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NATURE PRESERVATION IN ENGLAND

IN no field has lack of foresight been displayed more thoroughly than in rural planning and nature preservation in Britain. It is doubtful if any other European country can show such a black and desolate record.

A list of areas of primary scientific importance in England and Wales has been compiled by the Nature Reserves Investigation Committee. In a recent publication, "National Nature Reserves and Conservation Areas in England and Wales"*, these are recommended for permanent protection and preservation. The Committee deserves great praise for this excellent report, which not only presents a well-balanced and carefully chosen list, but also sets out the fundamental principles which should underlie any future general scheme for nature preservation. The only criticism one is tempted to make is directed towards the faintly apologetic tone in which the report is presented. The Committee also fails to stress the need for immediate action. An opportunity presents itself for considering some of the changes which have occurred to the biologically important parts of England during the past thirty years, as a somewhat similar list was compiled in 1915 by the late Hon. N. Charles Rothschild (see par. 5 of the Nature Reserves Investigation Committee report) for the Ministry of Agriculture. For purposes of such a comparison it is as well to take England alone. The Nature Reserves Investigation Committee adopted the system of dividing the country into areas to be surveyed and reported upon by local sub-committees. Their recommendations were then sifted and assessed by the central committee. A fundamentally similar method was chosen by Mr. Charles Rothschild, who, with the collaboration of the Society for the Promotion of Nature Reserves, circularized the various natural history societies and clubs then in existence and wrote personally to a large number of men of science. Of the one hundred and seventy-four areas selected by him as a result of these inquiries, one hundred and fifty have been re-selected by the present-day sub-committees. In fact, a number of the county lists are identical. The reasons given for omitting or discarding the twenty-four additional areas are as follows : (*a*) twelve areas are not now known to be of special scientific interest ; (*b*) twelve have been totally destroyed—by building and commercial development (5), draining and ploughing (3), planting with conifers by the Forestry Commission (3), and uncontrolled spread of bracken (1).

Thus, in the course of thirty odd years, the scientific value of about 7 per cent of England's biologically most important areas has been completely destroyed. This, however, is a very misleading picture, for the

* "National Nature Reserves and Conservation Areas in England and Wales." Report by the Nature Reserves Investigation Committee. (Conference on Nature Preservation in Post War Reconstruction. Memorandum No. 6.) (London : Society for the Promotion of Nature Reserves, British Museum (Natural History), 1945.) 3*s*.

damage and loss actually incurred is far in excess of that suggested by the modest figure of 7 per cent. Although the Nature Reserves Investigation Sub-Committee has re-selected most of the areas chosen by Mr. Charles Rothschild, a large proportion have been greatly changed and partially spoiled in the intervening period. Thus we find that areas which headed county lists in 1915 have now fallen to the bottom of such compilations. A closer examination of selections made, for example, in the County of Northampton will illustrate this point.

(1) *Harleston and Dallington Heath.* First choice on the 1915 list—not included among first eight areas of 1945 list. A portion sold by previous owner and this section now closely built over. Some planting with conifers. (2) *Helpstone Heath.* Second choice on 1915 list, first choice on 1945 list. Ownership unchanged, but one portion requisitioned and ploughed by the War Agricultural Executive Committee; another portion requisitioned by the Air Ministry and used as a practice bombing field (thus, fortunately, saving the vegetation). (3) *Swaddiwell Field.* Third choice on both lists. Ownership changed and interest largely destroyed by extensive quarrying. (4) *Oakley Purlieus.* Fourth on 1915 list, seventh on 1945 list. Ownership changed. Interest very largely destroyed owing to felling and extensive prospecting for ironstone. (5) *Sutton Heath and Bog.* Fifth on 1915 list, not included in 1945 list. Ownership changed. Totally destroyed owing to draining and ploughing by order of the War Agricultural Executive Committee. (6) *The White Water and Bog.* This area is the only one in the 1915 list which has remained unchanged.

There are, of course, a number of factors which have contributed to this unfortunate state of affairs. The fundamental cause, however, is lack of adequate planning. The Government has, for a number of years, imposed a heavy scale of taxation without providing a scheme to meet one of the direct results of such a policy—namely, the breaking up and sale of large country estates. It has been shown in the past that, owing probably to a combination of tradition, game preservation and a certain fundamental appreciation of the countryside, the potential nature reserve has been relatively safe (though inadequately controlled), in the hands of the British upper classes. A different state of affairs prevails to-day. The interests of the new owners are numerous and conflicting, and land is all too frequently a commodity in the hands of speculators.

Owing to war-time emergencies, the process of destruction has been greatly accelerated. The general unpreparedness of the country has meant that organisations such as War Agricultural Executive Committees and the Timber Control (Ministry of Supply) have had to work without detailed or properly laid plans and with little opportunity for collaboration. One has witnessed, for example, good and productive agricultural land laid waste as a practice bombing ground, and a few miles distant a unique heathland put under the plough. In most cases this type of destruction is due, not to the pursual of a stern and ruthless policy, but to praiseworthy zeal combined with lamentable, if pardonable, ignorance.

It is sad to reflect that, thirty years ago, a very adequate list of areas which called urgently for preservation was presented to the Government for consideration; but no action whatsoever was taken. Another list has now been prepared with equal care and deliberation. At first sight the similarity between these two lists may lull the superficial inquirer into a sense of false security. It has been shown in the foregoing paragraphs that the situation, far from being satisfactory, is extremely serious. If the Government procrastinates further, and 'pigeon-holes' the present report for another thirty years, it is safe to say that any third list will have little, if anything, in common with its two predecessors.

Turning once again to the published recommendations of the Nature Reserves Investigation Committee, one is tempted to ask if the very modest demands are sufficient to meet the present emergency. The main Committee has felt bound to whittle down the recommendations to forty-six national nature reserves (which "could be enclosed in a rectangle of less than twelve by ten miles"), and twenty-five conservation areas. (There are also proposals for three national parks.) Even if the Government takes immediate action (now so long overdue) with regard to these sites of special interest and importance, the results are bound to be somewhat disappointing and inadequate. These seventy reserves constitute less than half the areas considered in urgent need of protection by both past and present naturalists. Bearing this in mind, special attention should be given in the appropriate official quarters to paragraph 27 of the Nature Reserves Investigation Committee's report (p. 12), which emphasizes the need for local action. The regional sub-committees appointed by the Nature Reserves Investigation Committee would be the obvious and ideal bodies to carry out the task of promoting local interest and preservation. Every effort should be made to turn them into permanent organisations. It is perhaps unfortunate that the word 'Nature' has come to be associated in certain sections of the public mind with a somewhat childish or eccentric form of botanizing, bird-loving and butterfly-hunting. If the more fashionable word 'science' could replace 'Nature' on the sub-committees' note-paper they would probably find the task of co-operating with local authorities less uphill work. Again, if the Ministry of Town and Country Planning would accord them some measure of support they could, in collaboration with the war agricultural executives, catchment boards, Forestry Commission, Timber Control, county councils and the other innumerable bodies concerned, achieve great things. The history of the National Trust proves, if proof were needed, that the British as individuals are public-spirited and not indifferent to the fate of the countryside. But the shape of things to-day is such that it is virtually impossible for a small voluntary local organisation, however enthusiastic and energetic, to achieve results without some form of official recognition.

TOXICOLOGY

Leçons de toxicologie

Par Prof. René Fabre, avec la collaboration de Mlle. M.-T. Regnier et P. Chéramy. 1: Introduction à l'étude de la toxicologie; généralités sur les poisons. Nouvelle édition. Pp. 166. 50 francs. 2: Toxicologie des gaz, Première partie. Pp. 128. 45 francs. 3: Toxicologie des gaz, Deuxième partie. Pp. 148. n.p. 4: Alcools, anesthésiques, solvants. Pp. 150. 80 francs. 5: Acide cyanhydrique, dérivés aromatiques. Pp. 88. 70 francs. 6: Poisons organiques divers. Pp. 116. 85 francs. 7: Alcaloïdes, Première partie. Pp. 110. 85 francs. (Actualités scientifiques et industrielles, 935, 953, 956, 961, 963, 964, 965.) (Paris: Hermann et Cie., 1943.)

THIS series of books, of which seven out of the proposed twelve volumes are reviewed here, forms a précis of lectures on toxicology delivered to the Pharmaceutical Faculty in Paris. The lectures are given to students of pharmacy and industrial hygiene as well as to research workers. Such an audience would no doubt have somewhat different points of view, and the lectures certainly attempt, with notable success, to cover their diverse requirements. It is appreciated that the author must have been in some difficulty to decide what to include and omit, and how extensively to cover each section and topic discussed.

The present work is in its second edition and has been rewritten to include a greater wealth of practical detail, a discussion of topics related to toxicology and also to give information concerning French legislation as applied to industrial diseases. The text is copiously supplied with tabulated information, largely related to animal experiments. Each volume is complete in itself and provided with a table of contents which shows careful division and subdivision of the topics discussed, but there are no indexes.

It is noticed that the majority of the workers to whom reference is made are French, and the considerable number of American, English and German workers in the field of toxicology has received scant mention. This does not necessarily detract from the quality and scope of the presentation or completeness of the treatment of the subject, since the problems discussed have apparently fully exercised workers in France, but several modern modifications of chemical tests have thereby been omitted. The reason for this omission may well be the inaccessibility of foreign literature to French students. It is unfortunate that all references have been relegated to the twelfth volume, which is not yet available.

It was with some surprise and considerable interest that the reviewer found such a high standard of book production emanating from Paris in 1943—a Paris under enemy occupation. The paper, the clarity of the print and the general format all maintain the high reputation enjoyed by Hermann et Cie. English readers accustomed to war-time economy standards will find generous margins and spacing conducive to easy reading.

Volume 1, as an introductory volume, deals very fully with the various methods of poisonings, their *modus operandi*, distribution and destruction in, and elimination from, the body, concluding with theories of toxicity and treatment in cases of poisoning. Much of the information given in this and the other volumes is difficult to secure elsewhere within the confines of a single work.

Volumes 2 and 3 are devoted to the gaseous poisons including compounds of the halogens, sulphur, nitrogen, phosphorus and arsenic, as well as carbon monoxide, volatile hydrocarbons and 'war gases'. There is a considerable section of an elementary character dealing with the manipulation of gases. In passing, it would appear that the use of interchangeable glass apparatus with standardized joints and other modern appliances have not yet been adopted in French laboratories—at least, it is not mentioned. The remainder of these two volumes gives a very comprehensive account of the chemical and physiological properties of these poisons together with sensitive methods of test.

For the determination of carbon monoxide in blood, references are made to spectroscopic and spectrophotometric methods, but most attention is paid to a gasometric method. The carbon monoxide and other combined and dissolved gases are released by a reduction in pressure from blood acidified with tartaric or phosphoric acid, and collected in a suitable vessel for analysis. The method requires 25–100 ml. blood and would not appear to offer any advantage over the elegant Hartridge reversion spectroscope method. This latter technique is not mentioned.

Volume 4 deals with solvents such as carbon disulphide, the alcohols, refrigerants, chlor-compounds, ethers and esters. Considerable space is devoted to both ethyl and methyl alcohol intoxication and the researches of Nicloux and Widmark. Animal and human experiments carried out in France on the distribution and fate of alcohol in the body are described at length. The calculation from the blood-alcohol figure of the alcohol consumed is based on the formula of Widmark, which takes into consideration the weight and sex of the person examined. Although no stated legal ruling is given, it appears from the text that in France persons with less than 0·05 per cent alcohol in the blood are not considered inebriated, those with 0·05–0·2 per cent can be suspected of intoxication, while above 0·2 per cent alcoholic intoxication is certain.

Volume 5 is concerned with hydrogen cyanide, phenols, nitro- and amino-compounds. Both the toxicity and detection of sulphonamide drugs in general are discussed, but no details are given of individual members of this group.

Volume 6 opens with a historical survey of extraction methods for non-volatile acidic and basic drugs from viscera and body fluids. Barbiturates are discussed at some length. Workers with barbiturates will realize the importance of melting-point data, but only those of four of the commoner barbiturates are given. Other known tests, distinctive so far as the similarity of the homologues permits, are not, in the reviewer's opinion, adequately mentioned. In view of the comprehensive treatment given to the other drugs, it is to be hoped that this omission will be rectified in a subsequent edition. Considerable space in this volume is also devoted to animal, vegetable and bacterial toxins.

Volume 7 is the first part of two volumes devoted to alkaloids. The first chapters deal with ptomaines and leucomaines—the alkaloids of animal origin formed during life including adrenaline, choline, muscarine and others. These are followed by coniine, areca, opium and the morphine derivatives. There is also a full and very useful account of the properties of Indian hemp; and the volume has an addendum on French legislation relating to dangerous drugs.

In examining viscera and other material for drugs, it frequently happens that the material sought is unknown. For this reason a systematic scheme for identifying organic poisons is most necessary and should form part of any treatise on toxicology. Judging from the outline of this series of lectures as given in Volume 1, the inclusion of such a scheme is not contemplated. This should be rectified.

When the twelve volumes are available, the collection will form a very useful work of reference for students in many branches. There are sufficient practical details of methods and tests for the laboratory worker and a wealth of detail for those for whom the lectures are designed.

C. G. DAUBNEY.

THE WIDE OUTLOOK

France and Britain

A Report by a Chatham House Study Group. Pp. 110. (London and New York: Royal Institute of International Affairs, 1945.) 6*s*. net.

What is a Nation?

H. Stannard. (London and New York: Royal Institute of International Affairs, 1945.) 1*s*. net.

International Law

N. Bentwich. (London and New York: Royal Institute of International Affairs, 1945.) 1*s*. net.

The Problem of Austria

E. J. Passant. (Oxford Pamphlets on World Affairs, No. 72.) Pp. 32. 6*d*. net.

The Tropical Far East

J. S. Furnivall. (Oxford Pamphlets on World Affairs, No. 71.) Pp. 32. (London: Oxford University Press, 1945.) 6*d*. net.

THE general assembly of United Nations at the beginning of 1946 is the crowning example of the now familiar fact that world affairs occupy the attention of the simplest citizen of any civilized country. The following remarks on the subject arise out of a few publications, particulars of which are given above, that have reached *Nature* office. The first three of them are issued by the Royal Institute of International Affairs, and the next two have recently been added to the Oxford Pamphlets on World Affairs.

The Royal Institute of International Affairs is an unofficial and non-political body, founded in 1920 to encourage the study of international questions. It is precluded by its charter from expressing opinions, and so any opinions expressed in its publications must not be taken as those of the Institute. The volume entitled "France and Britain" is a summary of the work of a group of experts, invited to discuss the problems raised by Anglo-French relations after the War. The old links between the two countries are being re-established, and both are pledged to co-operation. This co-operation cannot last, however, unless its part in the wider system of United Nations collaboration is clearly grasped. To further this understanding is the object of this report. The report does not aim chiefly at reaching conclusions, but at helping the reader to form his own judgment. This aim the writers have achieved admirably well. Holding the view that other than the purely political factors must be taken into account, they have included chapters on economic collaboration and cultural relations.

The Royal Institute publishes also a new series of pamphlets on reconstruction bearing the general title "Looking Forward". The general editor of the series contributes the pamphlet entitled "What is a Nation?", and the pamphlet on international law comes with the high authority of Prof. Norman Bentwich. Though the terms are elusive, yet we do mean something when we speak of nationality, and we do mean something when we speak of international law. As Prof. Bentwich remarks about the latter, it is as much a fallacy to think that there is no international law as to think that international law binds States in the same way as the laws of a country bind its citizens. These basic issues are handled in the light of history so as to stimulate thought and discussion. The main object of the writers is to help the intelligent reader to judge for himself.

The next two pamphlets are recent additions to the Oxford Pamphlets on World Affairs. Much has happened since Mr. Passant's "The Problem of Austria" was issued. But it would be a mistake to suppose that the pamphlet is now out of date and useless. Though the Austrian Government is recognized by the Great Powers, the Allied Council for Austria is still in control, and there is no final settlement. It is impossible to understand the real meaning of Dr. Renner's Government without some knowledge of historical background, and here Mr. Passant's pamphlet is of service. In a different way Mr. Furnival's pamphlet on the tropical Far East, written from first-hand knowledge derived from years of residence in that region, helps the reader to understand the basic factors, which will probably remain unchanged.

It will be seen that all the publications here noticed are marked by the broadly scientific spirit. Their only bias is in favour of truth, and their chief aim is to help their readers to form clear conceptions concerning the problems with which they deal.

T. RAYMONT.

HISTORY OF MEDICINE

A History of Medicine

By Dr. Douglas Guthrie. Pp. xvi+448+72 plates. (London and Edinburgh: Thomas Nelson and Sons, Ltd., 1945.) 30*s*. net.

AS Dr. Guthrie points out in his preface, there is no systematic teaching of medical history in British medical schools at the present time. This study is, in fact, a luxury which is denied the average medical student whose curriculum is already so full as to keep him occupied with more profitable reading (from the point of view of examinations) in his spare time. Few would suggest that the systematic study of the history of medicine should be added to the syllabus of medical studies; but there is no doubt of its mnemonic qualities when it is judiciously interpolated into clinical teaching. The aphorisms of Hippocrates constitute a good example of ancient medical literature which can be translated into modern usage, and the late Mr. Russel Howard, surgeon at the London Hospital, used them with great effect to improve the minds and memories of his students.

The study of the writings of the great men of the past is instructive in demonstrating a capacity for careful observation which is too rarely possessed or acquired by the modern physician, who has come to rely too much on tests (pathological, radiological,

etc.), and seems to have forgotten to use his eyes. There is little in modern descriptive clinical medicine which was not known a century ago; it is only the interpretation of the phenomena which has changed. I myself once 'discovered' a sign of diagnostic importance in certain cases of syphilis, but was chagrined later to find that Alfred Fournier had made the same observation nearly a hundred years before.

There is little choice for the author of a general history of medicine in the manner of presentation of his subject, and this book could be described as a collection of short biographies in chronological order, suitably correlated. The progress of medicine is followed in this way through all the ages to the present day.

The compression of an enormous subject into four hundred small pages has been achieved without omission of any important figure or event. It is the fault, not of the author but of space and subject, that, in parts, the book reads more like a work of reference than a coherent story. Most of those who are interested in medical history have to be content, for want of time, to devote themselves to a special subject. Such people cannot expect to find this book complete in detail; but adequate references for further reading are included for anyone who is moved to enthusiasm by any particular personality or branch of medicine.

Apart from the broad survey, Dr. Guthrie has rounded off his work with chapters on military and naval surgery and tropical diseases, the rise of specialism and of preventive medicine, and on medical journalism and bibliography. There is a comprehensive classified bibliography of medical history. The illustrations are interesting, but suffer by being printed in an unattractive colour.

No notice of this book would be complete without a reference to Mr. Bernard Shaw's review (*Observer*, October 14, 1945). Mr. Shaw's views on modern medicine are unorthodox, severely critical, and very amusing, but they are, as expected, so well stated that Dr. Guthrie would do well to reprint the whole article in his next edition. Indeed, I would suggest an appendix on Shavian medicine with notes on Mr. Shaw's medical friends.

I concur with Mr. Shaw in recommending this book, which I enjoyed reading and which will provide me afterwards with a valuable work of reference.

J. MARSHALL.

VERTEBRATE PALÆONTOLOGY

Vertebrate Paleontology

By Prof. Alfred Sherwood Romer. Pp. ix+687. (Chicago: University of Chicago Press; London: Cambridge University Press, 1945.)

THE study of fossil vertebrates is a form of scholarship the importance of which is more fully realized in other countries than in Britain. We have about a dozen workers, while in the United States there are two hundred and fifty; and the provision of laboratories and technical assistance in the two countries is at least equally disproportionate.

An adequate treatment of fossil bones is difficult because it demands from the student a very wide range of knowledge and techniques. The basis of all palæontology is an accurate relative chronology, and as fossil vertebrates can only be interpreted on a world-wide basis this means a familiarity with the correlation of sediments in all the continents, depending largely on invertebrate animals and plants. As the interpretation of a vertebrate skeleton always demands a consideration of its mode of life, it is necessary to consider the conditions of deposition of the sediments in which it was found, which takes one to palæogeography and its basis in tectonics.

But these things are ancillary to the main purpose of the investigation, the determination of the animal's structure and place in classification. Such anatomical studies have become more and more rigorous until the student of fossil fish is required to become so familiar, by dissection and study of serial sections, with the anatomy of recent fish that he can interpret the foramina and other markings on a skull in terms of soft parts which were related to them. But this increased precision, which has characterized recent work on all groups, has greatly enhanced the value of fossil vertebrates, for it enables us to take full advantage of the extreme complexity of structure which they present. In general, it may be held that the greater the complexity, the more are the independent or quasi-independent characters which are available for the establishment of relationships and the tracing of evolutionary changes. As a final judgment must be made on a totality of characters, it seems that the evidence behind an evolutionary series of vertebrates must be much greater, and capable of much more critical examination, than that presented by a comparable series of Lamellibranch shells.

The interpretation of such series has as its ultimate aim not only an understanding of the course of evolution but also an inquiry into the mechanism which has brought it about. It is a fundamental condition of such a study that nothing must be postulated which cannot be shown to be consonant with conditions to-day. For example, it is idle to suggest a widespread occurrence of interspecific crosses occurring in Nature, for such conditions seem not now to exist, and by contrast to the appearances among plants, where they are common, seem never to have played any important part in animal evolution.

Evolutionary series of vertebrates have another great advantage in that, as much knowledge of the soft structures may be derived from the skeleton, it is often possible to discover the functional significance of evolutionary changes, to determine whether they are consequential to other modifications or themselves help to fit an animal more adequately for some specific mode of life. Unfortunately the individuals of the only group of invertebrates which would offer comparable possibilities, the Echinodermata, are so strictly tied down to precise ecological niches that they have as yet given us few evolutionary series other than those short stories to be found in the chalk.

Another great advantage of vertebrates is that they may give good evidence of the time and direction of migrations from one continent to another, a matter of much general interest. Thus the study of fossil vertebrates is of importance, for it gives us more fully than any other a history of life on the earth.

It is therefore very satisfactory that Prof. Romer has been able to publish a new, enlarged and admirable edition of his text-book. From it a student can learn much about the present position of the science in all its variety; and understand its significance both to biologists and geologists.

D. M. S. WATSON.

BUILDING RESEARCH IN GREAT BRITAIN*

By I. G. EVANS
Director of Building Research

SO much is being said nowadays about the need for additional research in connexion with the housing programme that there is a tendency to forget what has already been done in Great Britain. In fact, during the period between the two world wars, the foundations of a real science of building were solidly laid. This work has been centralized in the Building Research Station of the Department of Scientific and Industrial Research, though sister establishments, notably the Forest Products Research Laboratory, the Fuel Research Station and the National Physical Laboratory have also made their contribution.

It is of interest to recollect that the foundation of the Building Research Station was a direct result of the housing problems that remained with us after the First World War. The Department of Scientific and Industrial Research undertook its first researches on building materials and construction at the instance of a committee of the Local Government Board, which was considering, during the War of 1914–18, the problems of post-war housing. The Department appointed a Building Materials Research Committee to advise on this work; but later, in 1920, the committee was superseded by a Building (Materials and Construction) Research Board which was given the task of co-ordinating and supervising the wider range of building research which the Department was then being called upon to undertake, particularly by the Ministry of Health, which had absorbed the Local Government Board. Later still, the expressed need of the Ministry of Health for an acceleration and expansion of the work in relation to housing was a factor which, in 1925, led to the decision to move the Building Research Station from temporary premises at East Acton to its present site near Watford, where better provision could be made for its increased activities.

The first Director of Building Research, appointed in 1921, was Mr. H. O. Weller; he was succeeded in 1924 by Dr. R. E. Stradling (now Sir Reginald Stradling), under whose guidance the organisation was developed until, in 1939, he was seconded for duty with the Ministry of Home Security.

Initially, the Station concentrated on the study of building materials. There was much to be learned. The building industry was traditional in character, but success on this basis was possible only so long as workmen continued to use their local materials; things went wrong when labour and materials became more mobile. Organised scientific study of the materials and of the methods of using them became essential. But building is not merely a matter of the materials. Good building must take account of the conditions required for comfort and convenience in use. For example, the houses must not be expensive to heat; they must provide adequate natural lighting; they must be reasonably quiet; and the Station was soon drawn into the examination of these problems. It was also necessary to seek the advice of the physiologist on the various environmental conditions needed for human well-being. Thus, the Building Research Board has, for many years, had a joint committee with the Medical Research Council on problems of heating and ventilation.

As the work developed, the emphasis on housing became less pronounced. There is, of course, no sharp dividing line between research on building materials and methods of construction for housing and similar research for building generally; and, indeed, research on building problems is common, over a considerable field, with research on civil engineering problems. Inevitably, therefore, the scope of the Station's work came to embrace constructional problems on a wide basis. A notable example was in the study of soil mechanics, in which the Station has come to be concerned with the stability of earth dams, embankments and cuttings and retaining walls, and has acquired knowledge which has found useful application in connexion with reservoir construction, railway, dock and harbour work, flood protection schemes and so on.

The development of the Station during the inter-war period may be judged from the fact that in 1924 the total staff was 34. The scientific and technical staff included five graduate engineers, five graduate chemists, one graduate physicist, and three architects and builders; whereas in early 1939 the staff totalled 213, including 68 officers of graduate or other equivalent standard.

The services of the Station to the public throughout this period were steadily developed. Inquiries from the building industry were encouraged and were dealt with as a free service when they could be answered from existing knowledge. Where a particular inquiry called for further experimental work, this might also be done without charge if the matter was of sufficient general interest; otherwise the inquirer was expected to bear the cost of the work. It was also possible for firms to have their products examined at the Station on a repayment basis, and to receive either detailed reports on their performance or brief 'records of test' if only routine tests on particular samples were involved. On a wider scale, arrangements for co-operative researches of some magnitude on problems of general interest to particular sections of the industry were made with professional institutions and groups of building materials producers. In such instances the outside body concerned contributed to the cost of the work on an agreed basis.

Despite these activities, the amount of money received in repayment charges remained relatively small, and has at no time exceeded 17 per cent of the Station's total annual income. The bulk of the work is undertaken as a charge on public funds and in the general interest: and in all arrangements with individual firms or other outside bodies, the right is reserved, subject to prior consultation with the contributing firm or body, to publish the results of the work should it seem necessary in the public interest to do so.

The results of the Station's work are made available through annual reports, technical papers, special reports and bulletins published by H.M. Stationery Office, by the submission of papers by members of the staff to technical and scientific journals and, before 1939, by the issue every month to some thirty trade and technical journals of "Notes from the Information Bureau". On occasion unpriced leaflets are prepared and issued. For example, a series of some twenty leaflets are now in process of publication on different aspects of the general problem of the repair and restoration of war-damaged and neglected property.

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With the outbreak of war in 1939, new problems soon arose and the normal programme was very largely suspended. Much advisory work was done in connexion with protective measures, such as the design of air-raid shelters and blast walls, anti-scatter treatments for windows and roof glazing, and fire prevention. Special attention was also given to the design of war-time factories which had to be erected speedily with minimum quantities of scarce materials.

The Station also undertook research on various other problems for which it happened to have the right kind of experience and facilities. Thus, to quote a few examples, a process for the manufacture of phosphate fertilizer was developed; the design of reinforced concrete railway sleepers was investigated; and the Station co-operated with the Ministry of Aircraft Production and the aircraft industry in developing reinforced concrete jigs for use in the manufacture of the De Havilland 'Hornet' and other aircraft of plywood construction.

At the same time, it was kept constantly in mind that the end of the War would have to be followed by a period of intensive reconstruction and, from 1942 onwards, the Station was marshalling its information, so far as other calls on its staff allowed, to ensure that the fullest possible use should be made of the new science of building when the time came. Later the pace was quickened.

Undoubtedly the most significant contribution made by the Station in connexion with reconstruction has been the work done for the Interdepartmental Committee on House Construction (the Burt Committee). This committee was appointed in 1942 by the Minister of Works, the Minister of Health, and the Secretary of State for Scotland, to advise on forms of house construction suitable for the post-war programme. The resources of the Building Research Station have been put freely at the disposal of the Committee. A critical point in this general connexion has been to provide quantitative standards of performance both for the guidance of the designer and for use in assessing the merits of novel forms of construction. The necessity for this is clear. The performance of the traditional brick-and-timber house is well established and it might almost be said to be scarcely necessary to consider what, in fact, are the scientific standards that such a house satisfies. We know that it will stand up; we know that it provides an amount of thermal insulation which has been accepted as reasonable in the past; we know that it is reasonably quiet and that it does not present any undue fire risk. But in making radical departures from this traditional form of construction, it is very necessary that measurable scientific standards should be laid down. The Interdepartmental Committee has found it possible, on the basis of the scientific work carried out in the inter-war period, for the first time to advance suggestions as to what these standards should be. In considering this matter, the Committee has not been content merely to reproduce as nearly as possible the conditions of the brick and timber house, but has examined afresh what the desirable standards are, irrespective of whether they happen to be higher or lower than those provided by the brick and timber house. The accompanying table, taken substantially from the Committee's report, which has been published as "Post-War Building Studies No. 1", sets out the recommended standards and also shows how the brick and timber house stands in relation to them.

PERFORMANCE OF BRICK AND TIMBER HOUSE IN RELATION TO PROPOSED STANDARD

Element of house	Requirement	Value	Desirable standard	Value compared with standard
Outside wall: 11 in. cavity wall (two leaves of 4½ in. brick separated by a 2 in. air space, unventilated), plastered internally.	Thermal insulation	0·30[1]	0·15–0·20	Low
Outside wall (Scottish practice): 9 in. solid brickwork, roughcast outside and with lath and plaster fixed on battens of 1½ in. by 1 in. on the inside, giving 1 in. air space between plaster and wall.	Thermal insulation	0·28[1]	0·15–0·20	Low
Party wall (wall separating two houses): 9 in. solid brickwork, plastered on both sides.	Sound insulation[2] Fire resistance[3]	50 db. 6 hr.	55 db. 2 hr.	Low Ample
Partitions (walls between rooms which give no support to the structure): 2½ in. clinker blocks, plastered on both sides.	Sound insulation between living room and other main rooms Between other main rooms	About 35 db. About 35 db.	45 db. 35 db.	Low Adequate
Ground floor: ¾ in. (1 in. nominal) tongued and grooved floor boards on timber joists, ventilated underneath, covered with lino. Wood block floor on concrete laid direct on ground.	Thermal insulation Thermal insulation	0·25 0·15	0·15 0·15	Low Satisfactory
First floor: 1½ in. floor boards on timber joists: lath and plaster ceiling under joists.	Sound insulation air-borne Sound insulation impact	35–45 db. Standard	For flatted dwellings only, 55 db. +20 phons	For flatted dwellings only, low Low
First floor (Scottish practice): ¾ in. (1 in. nominal) tongued and grooved floor boards on joists. Trays of ¾ in. board fixed between the joists carrying 3 in. of ashes. Lath and plaster ceiling under joists.	Sound insulation air-borne Sound insulation impact	50 db. +10 phons	55 db. +20 phons	Low Low
Roof: Tiles fixed on battens with continuous layer of felt between this and the rafters. Lath and plaster ceiling under ceiling joists.	Thermal insulation	0·43	0·20–0·30	Low
Roof (Scottish practice): Slating direct on felt underlay on ¾ in. sarking (boarding). Lath and plaster ceiling under ceiling joists.	Thermal insulation	0·35–0·30	0·20–0·30	Low

[1] Thermal insulation figures are expressed throughout in terms of *U*, the transmittance coefficient. A high value of this coefficient means low insulation.

[2] The values given for sound insulation refer throughout to the reduction of air-borne noise, except where impact noise is specifically mentioned. The decibel (db.) is a unit of measurement of sound energy and is usually used for measuring air-borne sound. The phon is a unit of loudness (not necessarily equivalent to the energy) and is usually used for the measurement of impact noises.

[3] As tested under the standard conditions laid down in British Standard Definitions (No. 476, 1932).

It would not be right to quote these standards, without at the same time adding that the Committee recognized that "For one reason or another, it may be difficult, particularly in the immediate post-war years, to realize all the suggested standards; nevertheless, they should represent the aim until sufficient further experience has been gained to warrant a review of them".

The Building Research Station has, moreover, been responsible, on behalf of the Interdepartmental Committee, for the scientific checking of all designs for which licences have been sought from the Ministry of Works. Usually helpful comment can be made after inspection of the drawings only. Confirmatory tests may, however, be needed to check, say, the thermal insulating value of a particular method of wall construction; and later, when a prototype building is erected, full-scale tests may be made in final confirmation of any doubtful points. For example, test loads are applied to ascertain the behaviour of the structure under specified wind and snow loads; party walls are tested for soundproofness; and so on.

It is of interest to contrast this state of affairs with that existing after the War of 1914–18. Then, as now, there were big arrears of house building and replacement to be made good. But scientific knowledge about buildings was, in the earlier period, almost completely lacking, and this was responsible for some of the difficulties encountered with new constructions. Now there is a clear scientific basis of design so that alternative types can be proposed with much greater confidence that they will prove satisfactory, and it seems that some at least will come into extensive use.

Within the framework of the post-war study committees established under the ægis of the Ministry of Works, the Building Research Station has also been active in connexion with five special inquiries made by committees of the Building Research Board on heating and ventilation, lighting, acoustics, fire grading and plumbing. All these committees have presented reports, four of which, on the heating and ventilation of dwellings, lighting, acoustics and plumbing, have been published in the post-war building study series. The fifth should appear shortly. In the course of this work the need for some sociological inquiries became apparent, and arrangements were made with the Wartime Social Survey of the Ministry of Information to conduct surveys on the heating and ventilation, lighting and sound insulation in low-cost housing. These have provided a valuable basis for further inquiry and research.

The work for these study committees, however, is but one example of the efforts now being made to produce satisfactory standards for construction. On a much wider front, arrangements are in train for the production of a comprehensive series of codes of practice covering all aspects of building work as well as civil engineering and public works. It had been a frequent complaint in the building industry that complications are introduced by the differing requirements of different local authorities, of which there are fourteen hundred in England and Wales, and that great advantage would accrue from greater unification of practice. The model by-laws prepared by the Ministry of Health in 1937 represented a great step forward in this direction, for they have been adopted by the great majority of local authorities, so that, outside London, by-laws are, to all intents and purposes, uniform throughout Great Britain. But by-laws are necessarily concerned only with certain specialized requirements—requirements of a type such that failure to comply can be discouraged by legal penalties. A whole range of problems of everyday practice are in no way touched upon in the by-laws, and the codes of practice will fill this gap. Even before the War, the Building Research Station took part in the production of codes of practice, for example, those for reinforced concrete structures and for steel structures; but the Station has always taken the view that the preparation of codes could not be regarded as one of its normal functions, and that it was more the function of the industry itself, and particularly of the professional institutions associated with the industry. During the War, an important step forward has been taken. With the encouragement of the Ministry of Works, acting in consultation with the Ministry of Health and other interested departments, the different professional institutions have combined together to form a Codes of Practice Committee which sits under a chairman appointed by the Minister of Works. This Committee has the duty of arranging for the production of codes of practice concerning all matters relating to building as well as civil engineering and public works. The codes will not be mandatory, except in so far as they may be made so by being made part of a contract; but, nevertheless, they should exercise a very wide influence on building work in Britain, because of the authority that lies behind them. When the series is completed, there will be available an authoritative statement of what is considered, to-day, to be good building practice. Much of this work is bound up with research activity and indeed is founded on research activity. Officers of the Building Research Station, and of other establishments of the Department of Scientific and Industrial Research, are attached to all the committees operating in their respective fields, and it is, in fact, scarcely an exaggeration to say that the venture could not have been undertaken were it not for the work which the Station has carried out in the past twenty years. Corresponding work, but of longer standing, is being undertaken in the field of standardization.

The Building Research Station serves as an advisory body to the various Government departments interested in building, and in this connexion the creation by the Ministry of Works of a scientific department, under Sir Reginald Stradling as chief scientific adviser, is to be welcomed as a stimulus both to research and the more effective application of its results.

Among the most recent developments, special mention may be made of a new series of large-scale experiments in house-building. The Station, with the help of the Ministry of Works, now has facilities for carrying out full-scale trials, under its own control, of ideas that have emerged from the laboratory. For example, eight experimental houses have already been erected in which different degrees of thermal insulation have been incorporated in the walls, floors and roof to obtain further information on the effect on heating costs of thermal insulation; and during the erection observations were made on building technique.

A feature of the organisation, which makes the Building Research Station unique, is the fact that it provides for the working together on the problems of the industry of teams of chemists, engineers, physicists and architects; so that it becomes a relatively easy matter to assess the practical implications of the results of investigations undertaken from a number of different points of view. It is part of the normal

day-to-day routine for chemists, physicists, engineers and architectural members of the staff to meet together to discuss the practical implications of information obtained. The effective teamwork thus made possible is commonly the subject of comment by visitors, particularly visitors from abroad. It now seems likely that other similar organisations will be established in the Dominions and other countries—an uninvited testimonial to the form of organisation which has been developed for the application of science to an industry so practical and traditional as building, and an acknowledgment of the value of the twenty-five years research work of the Building Research Station.

Finally, it is of interest to note how the basis of building research has been broadened as the work has proceeded. Starting in the relatively restricted field of materials and structures, the Station at once found it necessary to join hands with sister establishments of the Department of Scientific and Industrial Research having special facilities for certain classes of work. Then it became desirable to establish a link with the physiologist, through the Medical Research Council; and more recently the help of the War-time Social Survey of the Ministry of Information was enlisted for certain inquiries. Again, the Station is extending its work on materials to cover their assembly on the site, and the properties of the finished building. The main question now is one of scale, and this is under consideration by the Department of Scientific and Industrial Research.

SOME USES OF D.D.T. IN AGRICULTURE

THE discovery in recent years of a new class of insecticides has given man an advantage over his insect enemies such as he has never before enjoyed. Although these materials kill insects by contact, they possess a stability and persistence which confer a protective effect far exceeding that of any previously known contact insecticide. Best known among them is D.D.T., a substance the properties of which are so remarkable that it has been accorded the doubtful honour of becoming 'news'. Very little of the vast amount of experimental work done has yet been published, and the door has thus been opened wide to the wildest speculation and exaggeration. A meeting of the Association of Applied Biologists on October 5 sought to adjust the outlook at least upon some of the agricultural uses of D.D.T. by bringing together workers qualified to speak on original investigations.

Mr. C. T. Gimingham, of the Ministry of Agriculture and Fisheries Plant Pathology Laboratory, introduced the proceedings with a plea for a restrained and balanced approach. The peculiar circumstances in which D.D.T. was introduced had led to intensive investigations on an unprecedented scale. The substance had proved to be of inestimable value and, by controlling disease-carrying insects, had probably been a major factor in the success of several Allied campaigns. Unfortunately, much of the resulting publicity had not been in the highest tradition of scientific accuracy. Contrary to the popular view of D.D.T. as a cure-all, it had recently been reported in the United States[1] that while it excelled the commonly used insecticide against some thirty insect species, it was only about equal against nineteen and was inferior against fourteen. Most of the work so far had been exploratory, and increased knowledge of dosage, timing and compounding would doubtless lead to improved performance in many cases. At present little was known as to which of the variety of possible forms of application was most effective and safest for particular purposes. A special problem in agriculture was the risk of harmful effects upon beneficial insects. Injury to birds and fishes also might follow widespread use over large areas. There appeared to be little danger to warm-blooded animals, but more information was required about cumulative effects. D.D.T., said Mr. Gimingham, was of such outstanding interest and promise that it would be peculiarly unfortunate if its future were prejudiced by misuse in the early days.

Dr. G. H. L. Dicker described experiments at East Malling Research Station on the control of apple blossom weevil. Emergence from hibernation begins in late February or early March and may extend over five weeks. Egg-laying starts at bud burst and continues for about three weeks, so effective treatment demands continuous protection over this period, with the first application timed for bud burst. In laboratory tests a 5 per cent D.D.T. dust consistently gave more than 90 per cent kill in five days, and this concentration was chosen for field trial. In comparison a 5 per cent benzene hexachloride dust killed about 60 per cent, reaching the maximum in sixteen hours. In 1944, 60–70 lb. of 5 per cent D.D.T. dust per acre, applied as soon as practicable after egg-laying began and twice following at weekly intervals, reduced an infestation of 5–6 per cent to 0·02 per cent, whereas a 1 per cent rotenone dust gave only about 50 per cent reduction. In 1945 two applications of 5 per cent D.D.T. at 40–45 lb. per acre gave more than 90 per cent control, but at 3 per cent only about 60 per cent control resulted. In another trial, however, 3 per cent D.D.T. apparently gave no kill, whereas 3 per cent benzene hexachloride gave 50 per cent. It remained to be seen whether a single dusting with 5 per cent D.D.T. at bud burst would suffice, whether 5 per cent benzene hexachloride was as good, and whether control could be attained by wet spraying. A spray containing 0·05 per cent D.D.T. gave complete kill in laboratory tests. As the optimum time of application was a month before flowering, there seemed to be little risk to beneficial insects. Dr. Dicker thought that D.D.T. would be compatible with lime-sulphur or a winter petroleum wash, but he preferred the dust because of the speed of application and because the best time for the weevil treatment was after petroleum oil and before the first lime-sulphur. Dr. W. Heeley said that other trials[2] showed a wet spray to be far superior to a dust, but Dr. Dicker pointed out the surprisingly poor results given by the dust in these trials.

Dr. M. Cohen reported exploratory work on the production of D.D.T. 'smokes' by burning impregnated filter papers. The heavy smoke produced settled quickly and gave a firmly adhering deposit. By drawing this smoke through benzene, unchanged D.D.T. could be recovered. Houseflies, stable flies (*Stomoxys calcitrans*), Drosophilid flies, mosquitoes (*Culex* spp.), thrips, clothes moths, and pollen beetles were knocked down within five seconds of being exposed to the smoke. Aphides, though less obviously affected, appeared not to recover. The deposit produced when the smoke settled consisted of minute droplets that remained liquid until mechanically disturbed, as by brushing lightly or by the movement

of insects. This induced crystallization along the track of the disturbance, the resulting crystals closely resembling those of D.D.T. The deposit was assumed to contain D.D.T. as it gave a reaction for chloride after treatment with alcoholic potash. It was still toxic to house- and stable-flies after sixteen days, and the effect on the insects closely resembled that of D.D.T. Dr. Cohen reported that Mr. W. Steer had heated D.D.T. just above its melting point for several hours in a glasshouse. Paralysed white flies, aphides and caterpillars were afterwards found on the soil, and centipedes and a devil's coach horse beetle were affected. Foliage from the greenhouse plants was toxic to houseflies. These results suggested that the possible application of D.D.T. as a fumigant merited further investigation. Dr. R. L. Wain said the direct heat treatment described would certainly result in quantitative decomposition of the D.D.T.; the crystals formed from the smoke deposit might well be the ethylene derivative. A minute amount of unchanged D.D.T. could account for the effects described. He suggested that inorganic chloride should be estimated as a measure of decomposition. Dr. Kennedy said experiments at Porton showed that it was possible to make smokes in which a considerable proportion of the D.D.T. persisted unchanged.

Mr. K. J. Coghill and Mr. W. Steer discussed the effect of D.D.T. on flies in farm buildings. All the interior surfaces in one of two almost identical shippons were sprayed with 0·1 per cent D.D.T., and a fall in the fly population was evident within a few hours. Dead and moribund flies counted daily in the feeding passages were fully ten times as many in the treated shippon as in the untreated. In the following year the two shippons were transposed as untreated and treated. The number of dead flies in the untreated, though still less than in the treated, was much higher than the corresponding figure in the previous year, despite a much lower infestation. This suggests the persistence of a lethal effect for fourteen months in the shippon sprayed in the first year. *Stomoxys calcitrans* was the most abundant species involved in these trials, with *Fannia canicularis* next. *Lyperosia irritans* comprised less than 10 per cent of the fly population; but this species was unaffected since it did not leave the cattle and so never came into contact with treated surfaces. While the 'resident' population was substantially reduced by the D.D.T. treatment, there was a fresh influx of flies each time the cattle came in. Nevertheless, although affected flies continue to annoy the animals for at least fifteen minutes, the cattle in the treated shippon were usually quieter than those in the untreated. Flies were almost eliminated from a bull-box in which the animal was penned continuously. To test the efficacy of D.D.T. in lime-wash two calf pens were treated, one with lime-wash alone and the other with D.D.T. added. The latter pen had the higher fly population at the start, but the position was reversed after treatment. In the following discussion, Mr. Steer said no attempt had been made to spray the cows or to treat nearby gateposts, trees, etc. There had been no hint of harmful effects upon those applying the spray.

Mr. J. B. Cragg described field trials on the control of sheep blowflies, chiefly *Lucilia sericata*. Following promising laboratory tests, Welsh mountain sheep were dipped in a bath containing 0·5 per cent D.D.T. in a finely dispersed emulsion, a commercial arsenic-sulphur dip being used as control treatment. There were far fewer strikes on the sheep treated with D.D.T. and the protection remained effective for six weeks[3]. This result was confirmed in a second season, but in parallel trials in other areas results were not so uniformly satisfactory, for example, with black-face sheep in Aberdeen, where D.D.T. was less effective than the proprietary dip. When a range of concentrations of D.D.T. was tried, 0·5 per cent was the minimum suitable for field use. Whereas the arsenic-sulphur dip is larvicidal, D.D.T. acts on the adult fly rather than on the egg or larva. Flies die after contact with the treated fleece and the action is sufficiently rapid to prevent normal oviposition. On the other hand, normal egg batches were laid within two days of treatment with an arsenic-sulphur dip. The odour of D.D.T. is not repellent to blow-flies and, indeed, by applying an attractant also, the sheep can be made a live blowfly trap. By rubbing together in the flock, dipped sheep can pass on the toxicity to untreated animals as is revealed by the fact that wool from the flanks, but not from the back, of untreated sheep is toxic to the flies. Although D.D.T. has not given complete control of sheep blow-fly it has substantially reduced the number of strikes and increased the period of protection in comparison with an arsenic-sulphur dip. Of the strikes that occurred, more than 90 per cent were in the region of the tail, a fact which indicates that a combination of D.D.T. treatment with crutching might be very effective. It is suggested, too, that since attack on the adult fly requires cover of the outside of the fleece rather than penetration to the base as with the current treatment, dipping might well give place to application by sprays or jets.

Mr. G. B. S. Heath and Dr. J. G. Mitchell reported similar field trials of D.D.T. against sheep ticks (*Ixodes ricinus*) on hill farms in Cumberland. In this area there is a major peak of infestation in April–May and a minor one in August–September. More than half the ticks on the animals were found on the ears and face; few were present in the fleece proper. In laboratory tests by Dr. E. T. Burtt, D.D.T. had given promising results, and field trials of several experimental emulsions of D.D.T. were started, using as control a commercial arsenical dip which reduced infestation significantly only for about fourteen days. Good control of ticks for seven weeks followed dipping in 0·5 per cent D.D.T., while 0·3 per cent gave protection for four weeks. The concentration of D.D.T. in the fleece exceeded 1 per cent, and rapid exhaustion of the bath occurred. But on repetition with a similar, though not identical, emulsion, protection was no better than with the control dip, the concentration of D.D.T. in the fleece did not exceed that in the bath, and this did not fall appreciably during dipping. The latter emulsion was much more finely dispersed than the former, and further work showed this to be the principal factor determining high or low deposition on the fleece and consequent tick control. In ordinary anionic emulsions the oil globules show no affinity for the fibre, but in cationic emulsions they are strongly attracted. Pre-treatment of the fleece with dilute acetic acid reverses these affinities. In field trials heavy deposits and good protection generally resulted from dipping in coarse anionic emulsions, in fine anionic emulsions after swabbing heads and axillæ with acetic acid, or in a cationic emulsion. A cationic dip containing only 0·2 per cent D.D.T. was effective.

Dr. Mitchell demonstrated the affinity relationships discussed. He said that although the emulsions used by Mr. Cragg and Mr. Heath were all experi-

mental, the success achieved had stimulated a vigorous demand among farmers for preparations for field use.

Answering questions, Mr. Heath said that spraying did not wet the fleece, but jetting at 150 lb. pressure did. The main growth of new fleece occurred after the tick season. The effect of D.D.T. on keds was even more spectacular than on ticks. Mr. Bracey wondered what retention of D.D.T. there was in the short hair of the face. If large crystals were deposited from a spray they might easily be rubbed off, so the problem might resolve itself into getting a deposit of the smallest possible crystals. [See also p. 311 of this issue.]

H. SHAW.

[1] *Soap*, **21**, No. 4, 139 (1945).
[2] *The Grower*, **23**, 430 (1945).
[3] *Nature*, **155**, 394 (1945).

ALKYL FLUOROPHOSPHONATES: PREPARATION AND PHYSIOLOGICAL PROPERTIES

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THIS article gives a very brief preliminary account of some of the work initiated and carried out on toxic fluorophosphonates during the War at Cambridge by an extra-mural Ministry of Supply research team working under our direction. For security reasons during the War, this work has not hitherto been published, though secret reports (which were also made available to American workers almost from the inception of the investigations) have from time to time been submitted to the Ministry of Supply. More detailed accounts of these investigations and a fuller bibliography will be published in due course in the appropriate journals.

Until this work began in Cambridge in 1941, the alkyl fluorophosphonates had received practically no attention. Lange[1] gave a tedious and laborious method for preparing dimethyl and diethyl fluorophosphonates in very poor yield as follows. Phosphorus pentoxide was fused with ammonium fluoride, a mixture of ammonium monofluorophosphonate and ammonium difluorophosphonate being produced. The monofluorophosphonate was converted into the silver salt which was then heated with the alkyl iodide, the overall yield being less than 4 per cent. Passing reference was made to an effect on the vision, but no record was made of the toxicity of these two compounds. No other fluorophosphonates were recorded. During 1941, we prepared several alkyl fluorophosphonates R_2PO_2F (R = Me, Et, *n*-Pr, *iso*-Pr, and *n*-Bu) and one of us made a preliminary report[2] to the effect that:

(1) These substances have high toxicity as lethal inhalants. Death takes place rapidly (for example, a concentration of 1 : 10,000 of the di-*iso*-propyl ester killed 6/6 rats, 10/10 mice and 2/3 rabbits within 25 minutes from the beginning of exposure of 10 minutes). Such rapid effect and quick knock-out action is shown by few other gases or vapours.

(2) At lower and non-fatal concentrations, a peculiar effect is produced on the eyes, quite distinct from lachrymation. The material causes the pupils to become acutely constricted, and the effect may last for several days. In addition there is interference with visual accommodation. There is no tear formation and little or no irritation produced in the eyes. Reading is rendered difficult and vision at night is seriously affected.

Synthetic Methods. It then became obvious that practicable methods of synthesizing fluorophosphonates must be devised, and in Report No. 2 on Fluorophosphonates[2] we proposed the following methods:

(1) $POCl_3 \rightarrow POCl_2F$
$POCl_2F + 2ROH = (RO)_2POF + 2HCl$
(2) $2(RO)_2PO + POCl_3 = 3(RO)_2POCl$
$(RO)_2POCl + NaF = (RO)_2POF + NaCl$
(3) $3ROH + PCl_3 + 3C_5H_5N = (RO)_3P + 3C_5H_5N,HCl$
$(RO)_3P + Cl_2 = (RO)_2POCl + RCl$
$(RO)_2POCl + NaF = (RO)_2POF + NaCl$

Method 1 and a modification of method 3 were destined to play a very important part in subsequent researches. In our next report[4] we showed that method 1 could be employed in the case of ethyl alcohol and phosphorus oxydichlorofluoride giving a 93 per cent yield of diethyl fluorophosphonate. (See also British Secret Patent[5].) In preparing the trialkyl phosphite (method 3), the use of pyridine imposed a severe restriction for large-scale preparation, and it was soon found that the cheaper and more readily available dimethylaniline could be used in its place[4,6].

Although substitution of dimethylaniline for pyridine provided an important modification in the preparation of alkyl phosphites, the method was still not sufficiently cheap for large-scale work. It was decided then to try the effect of eliminating the tertiary base altogether. The result of the action of phosphorus trichloride on ethyl alcohol was *diethylhydrogen phosphite* in high yield. It seemed at first that this modification was useless, as the required triethyl phosphite was not produced. We decided nevertheless to try the effect of chlorine on the hydrogen phosphite and found that the essential *chlorophosphonate* was produced in 80 per cent yield[6,7].

As subsequent reports will show, it may be said that this discovery altered the whole course of fluorophosphonate chemistry. It now became possible to prepare the fluorophosphonates in excellent yield[8] and from cheap and readily accessible materials, in particular no tertiary base being required.

The synthesis may then be represented as follows:

	Yield
$PCl_3 + 3ROH = (RO)_2POH + RCl + 2HCl$	89 per cent
$(RO)_2POH + Cl_2 = (RO)_2POCl + HCl$	80 ,,
$(RO)_2POCl + NaF = (RO)_2POF + NaCl$	84 ,,

Semi-Technical Scale. Further modifications were then made in this 'hydrogen-phosphite' method of preparing diisopropyl fluorophosphonate (the most toxic of the series) in order to put it on a semi-technical scale.

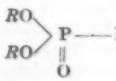
After a large number of experiments, we found that the preparation could be run virtually as a *one-stage process*[9]. Other simplifications were introduced, and the whole process now consists simply in adding phosphorus trichloride to isopropyl alcohol, dissolved in carbon tetrachloride, without external cooling. The crude product (still in carbon tetrachloride) is chlorinated and then heated with sodium fluoride. After filtration, the carbon tetrachloride is distilled off and the pure diisopropyl fluorophosphonate distilled[10,11].

This process formed the basis of the method employed both in Great Britain and afterwards in America for the production of this and similar compounds.

Although the action of $POCl_2F$ on an alcohol cannot compete with the 'hydrogen phosphite' method for large-scale work, the former was found extremely valuable for exploratory purposes. In particular, it was found possible to prepare diaryl fluorophosphonates [for example, $(C_6H_5O)_2POF$)] and diethyl dithiofluorophosphonate [$(C_2H_5S)_2POF$] by the action of phosphorus oxydichlorofluoride on the appropriate phenol or mercaptan[12].

Toxicity and Miosis

Employing the methods mentioned above, numerous fluorophosphonates and related compounds were prepared in Cambridge. The eye-effect was tested out on ourselves and members of the team. Toxicity tests by inhalation were carried out by Prof. E. D. Adrian[13] and his team (see below). The constricting effect on the pupil of the eye (miotic effect) and high toxicity by inhalation usually went together. By September 1942 we had established the fact[14] that



(I)

if R is *iso*-propyl or *sec.* butyl (Formula I) the toxicity was of a high order and higher than with a primary group (for example, R = ethyl, *n*-propyl, *n*-amyl, *iso*amyl). The lethal concentration ($L.C._{50}$) for mice (10 minutes exposure) for *iso*propyl fluorophosphonate was 0·44 gm./m.³ for deaths within 2 hours. Most of the deaths actually occurred within half an hour.

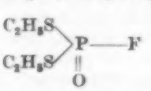
The toxicity of *sec.*-butyl fluorophosphonate was of a similar order.

Di*iso*propyl fluorophosphonate has very little odour. When human observers were exposed to a concentration of 1 part in a million of the vapour for 5 minutes, severe miosis started a few minutes after leaving the chamber. The pupil constriction and reduction in the powers of visual accommodation persisted for several days. Significant miosis can be produced by exposures sufficiently low as to give no sensory warning and to be undetectable chemically. This has been abundantly proved in this laboratory by workers who have taken great precautions when dealing with the substance (use of fume-cupboards, respirators, etc.) and yet vision has been blurred for several days. This observation has been confirmed by American workers.

Relationship Between Structure and Physiological Action

In Report No. 6[15], we also reported that miotic effect and toxicity became negligible when the fluorine atom in diethyl fluorophosphonate was replaced by the following atoms or groups:
—H, —OH, —Cl, $-C_2H_5$, $-OC_2H_5$, —SCN, $—NH_2$, $—NHCH_3$, $—NHC_6H_5$, $—OCH_2CH_2Cl$, —SH.

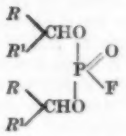
These physiological effects also disappeared when oxygen atoms were replaced by sulphur as in II.



(II)

We also showed that ethyl difluorophosphonate $(C_2H_5O).POF_2$ has neither miotic nor toxic action.

Early in 1943, we reported the preparation of di*cyclo*hexyl fluorophosphonate by the action of phosphorus oxydichlorofluoride on *cyclo*hexanol[14,15]. This liquid had the high toxicity expected of it, and intense pupil-constricting effect was observed with animals and human beings. Di-*sec.*-hexyl fluorophosphonate[16] also possessed high toxicity and miotic action.



(III)

From the examination of a large number of compounds, a striking correlation between physiological action and chemical constitution thus became clear, namely, that a secondary grouping increases potency; and furthermore, our results showed that for non-cyclic compounds, R and R^1 (Formula III) must, for the maximum results, be unsubstituted alkyl radicals. For example, di-α-carbethoxy-ethyl fluorophosphonate is scarcely toxic (R = $—COOC_2H_5$, $R^1 = CH_3$).

A few of the toxicities[13] for 10 minutes exposures (deaths within 2 hours) are summarized in the accompanying table. More precise figures and full details of the technique used will be given later.

Ester	L.C./50 in gm./m.³	Remarks
Di*iso*propyl fluorophosphonate	0·36 (rats) 0·44 (mice)	More toxic than phosgene. Quick knock-out action comparable with hydrogen cyanide. Strong miotic action
Di-*sec.*-butyl fluorophosphonate	0·6 (mice)	Strong miotic action
Di*cyclo*hexyl fluorophosphonate	0·11–0·14 (mice, rats and rabbits)	10-day observation: strong miotic action.

Summary

Numerous dialkyl fluorophosphonates have been synthesized by several methods in this laboratory, two of which proved to be particularly useful, namely, (1) the action of phosphorus oxydichlorofluoride on an alcohol, (2) the chlorination of a dialkyl hydrogen phosphite followed by fluorination. Both processes have been patented. The production of the dialkyl fluorophosphonate from phosphorus trichloride utilizing the second method has been reduced to a 'one-stage operation' and has been developed on a semi-technical scale.

The fluorophosphonates are stable liquids and in general are highly toxic by inhalation, having a quick knock-out action and possessing powerful miotic action. A strict correlation between chemical constitution and physiological action has been brought to light, and the fluorophosphonic esters of secondary alcohols are the most potent.

The use of some of the less toxic of these compounds as insecticides has been suggested by us[16]. We also claimed that some of these compounds might be useful as fungicides, bactericides and disinfectants, and may have clinical application[5].

We are indebted to the Chief Scientific Officer of the Ministry of Supply for permission to publish the above. We are grateful to Mr. Davidson Pratt for the interest that he has shown in this work, and to the staffs of the Chemical Defence Research Department, Ministry of Supply, in London, Sutton Oak and

Porton, with whom we have kept in close contact during the years 1939–45.

The following have taken part in these investigations at Cambridge:

H. McCombie; B. C. Saunders.

F. J. Buckle.	G. J. Stacey.
N. B. Chapman.	F. E. Smith.
H. G. Cook.	F. Wild (part-time).
R. Heap.	I. G. E. Wilding.
J. D. Ilett.	S. J. Woodcock.
F. L. M. Pattison.	

The physiological action on animals of most of the compounds described above were examined at the Cambridge Extra Mural Testing Station by:

E. D. Adrian.	B. A. Kilby.
K. J. Carpenter.	M. Kilby.

[1] Lange, *Ber.*, **65**, 1598 (1932).
[2] Saunders, B. C., Ministry of Supply Meeting (London, Dec. 11, 1941). See also Report No. 1 on Fluorophosphonates to Min. of Supply by McCombie, H., and Saunders, B. C. (Dec. 18, 1941).
[3] McCombie, H., and Saunders, B. C., Report No. 2 on Fluorophosphonates to Min. of Supply (Feb. 27, 1942).
[4] McCombie, H., and Saunders, B. C., Report No. 3 on Fluorophosphonates to Min. of Supply (March 28, 1942).
[5] British Secret Patent. Min. of Supply. H. McCombie, B. C. Saunders, N. B. Chapman and R. Heap (April 17, 1944).
[6] McCombie, H., Saunders, B. C., and Stacey, G. J., *J. Chem. Soc.*, 380 (1945). Cook, H. G., McCombie, H., and Saunders, B. C., *ibid.*, 873 (1945).
[7] McCombie, H., and Saunders, B. C., Report No. 4 on Fluorophosphonates to Min. of Supply (May 20, 1942).
[8] McCombie, H., and Saunders, B. C., Report No. 7 on Fluorophosphonates to Min. of Supply (Jan. 16, 1943).
[9] McCombie, H., and Saunders, B. C., Report No. 8 on Fluorophosphonates to Min. of Supply (March 1, 1943).
[10] British Secret Patent. Ministry of Supply, H. McCombie, B. C. Saunders (Sept. 15, 1943).
[11] Sutton Oak Report at Ministry of Supply Meeting (London, March 22, 1944).
[12] McCombie, H., and Saunders, B. C., Report No. 6 on Fluorophosphonates to Min. of Supply (Sept. 30, 1942).
[13] Reports to Min. of Supply from Cambridge University Extra Mural Testing Station, by E. D. Adrian, B. A. Kilby *et al.* (1941 onwards).
[14] McCombie, H., and Saunders, B. C., Report No. 9 on Fluorophosphonates to Min. of Supply (April, 1943).
[15] XL Report to Min. of Supply (Jan. 7, 1943).
[16] McCombie, H., and Saunders, B. C., Report No. 11 on Fluorophosphonates to Min. of Supply (May 27, 1943).

GEOLOGICAL STUDIES IN GREECE

By Prof. G. GEORGALAS
Department of Mineralogy and Petrology, University of Athens

IN geological research Greece has lagged behind the rest of Europe. This is mainly because, since its liberation in 1830, little attention has been paid to the exploitation of its natural resources. The opinion which persisted for nearly a century that the subsoil of Greece did not contain mineral wealth contributed to a great extent to the belief that the geological study of the country was valueless.

The few geological studies of particular regions which had been written up to 1910 came mainly from foreign men of science, and only a very few, principally by C. Mitzopoulos, Socrates Papavasiliou and Th. Skouphos, from Greeks. Many of the trunk roads and railways were projected without any previous geological survey to determine the nature of the rock to be cut, the possibility of landslides, etc. In the Corinth Canal, for example, there are frequent falls of great masses of rock from the sides, which are nearly vertical. The geological composition of the region was not studied beforehand in order to determine the proper inclination of the banks.

The compilation of a detailed geological map of Greece has not yet been begun. There are only geological maps, drawn to large scale (mainly 1 : 300,000) of some areas of Greece, made mainly by foreign scientific workers, particularly by the German, Prof. A. Philippson.

Greater interest in geological research in Greece began after 1910, inspired by my predecessor, Prof. C. A. Ktenas. Up to 1935, when he died, Ktenas had surveyed several regions of Greece, investigating the possibilities of exploiting industrial minerals, and also from a purely scientific point of view.

Both Ktenas and his predecessor, Prof. Mitzopoulos, had many years previously stressed the need for setting up a Geological Survey in Greece. Thanks to the persistent efforts of Ktenas and myself, it became possible for me to establish, in 1919, the present Geological Survey of Greece, which I directed until 1936. The Survey has experienced great difficulties. It began its work with a very small number of scientific workers and the sums provided by the State were always very meagre. Nevertheless, to date many serious studies have been made which have contributed to a fuller knowledge of some of the sources of natural wealth of the country. The following notes refer to some of the principal investigations which have been made.

I studied for the first time and announced the existence of deposits of bauxite in Greece. Up to 1922, these deposits were regarded—owing to incorrect chemical analysis—as deposits of iron ore rich in quartz (SiO_2) and therefore unsuitable for exploitation. The announcement was followed by the discovery by others of deposits of bauxite in various regions of Greece. It is at present known that there are deposits of bauxite in Phthiotis-Phokis (massif of Parnassos-Ghiona), the Island of Amorgos, near the town of Eleusis and elsewhere. The reserves of bauxite in Greece are estimated to be of the order of hundreds of millions of tons. In Phthiotis-Phokis alone it is estimated that there are more than fifty million tons of bauxite. The fact that these particular deposits are found near the falls of the River Acheloös, which could generate enormous electric power, promises the possibility of developing an aluminium industry in Greece.

I also studied the lignite deposits in Greece. The existing reserves are estimated to be of the order of several million tons. Research has still to be carried out on how and where Greek lignite could be used.

I have also investigated the outcrops of petroleum which occur in many places in Greece, especially in the region of Jannina (Epirus) and in western Thrace. Prospecting carried out at the expense of the National Bank of Greece in western Thrace did not give satisfactory results. The War unfortunately prevented prospecting in the Jannina region.

The personnel of the Geological Survey recently began to study the beds of kaolin on the Island of Melos in the Cyclades, but this work was also interrupted by the War. The quality of the kaolin is excellent and it only remains to determine the potential amounts available for exploitation.

The Geological Survey, both through myself and its other geologists, has assisted many small towns and villages in Greece on the question of a supply of drinking water. Assistance has also been given to the State services when measures had to be taken to rebuild inhabited areas devastated by earthquake, as

for example, those of Chalcidice, Corinth and Heraclion in Crete, etc.

The need for compiling a general geological map, even on the scale of 1 : 300,000, which would be of fundamental assistance to the various State services and to private individuals requiring general knowledge of the geological formations of each area, led me to begin the publication of such a map in 1936. In this work I made use of all the geological surveys made by foreign and Greek geologists published up to that time. All my maps were produced to a scale of 1 : 300,000 with identical conventional signs. So far only six sheets of this geological map have been published.

I have studied the geological formations and the hydrogeological conditions of the region of the dam and artificial lake of Marathon, from which the city of Athens to-day is supplied by water. I have also made geological surveys of some river valleys to investigate the possibilities of building dams to harness these rivers for electric power.

The Geological Survey now has a fully equipped chemical laboratory for the chemical analysis of the ores and rocks of the country and also for the physical, chemical and physico-chemical study of the mineral waters of Greece.

Greece is extremely rich in hot springs. The principal springs had already been examined chemically and classified, but on an out-of-date scientific basis; the Geological Survey has therefore classified each spring on modern scientific principles. These studies brought to our knowledge for the first time new varieties of spring as, for example, the radioactive springs of Kammena-Vourla (with a radioactive capacity of 120–300 Mache units) and of the Island of Icaria (with a capacity of up to 400 Mache units).

The Geological Survey of Greece has also carried out purely scientific studies. It observed and studied the two eruptions of the volcano of the Island of Santorin which took place in 1925–26 and in 1928. The results of the investigation of these eruptions were published, together with those made by the German Scientific Mission which came to Santorin, in Berlin in three volumes under the title "Santorin".

I organised a special section within the Geological Survey for the study of Greek soils. This section examined and classified the various soils in Greece and published several original monographs on some of the types of soil.

In my capacity since 1936 as professor of mineralogy and petrology in the University of Athens I have studied the phenomena of the latest eruptions (1939–41) of the volcano of Santorin. Only one provisional paper, read before the Greek Academy of Sciences, has been published so far. The study of the prehistoric volcanoes of the Ægean Sea and their lava flows, begun by my predecessor, Ktenas, has been continued by me.

In the last twenty years, a number of posts for scientific workers have been created in the Laboratories of Mineralogy, Petrology and Geology of the University of Athens. Here students are working with enthusiasm and energy on the minerals, rocks and geological formations of the country. Thus an adequate scientific geological staff to-day exists in Greece, able and willing to give its services in the study of the soil of Greece and to evaluate its wealth in the new era of struggle now beginning for my country—the struggle for the reconstruction of Greece and the creation of a new and higher Greek civilization.

OBITUARIES

Dr. Francis William Aston, F.R.S.

Aston's name is associated in the minds of men of science with the mass spectrograph and the discoveries concerning isotopes to which it led. In the history of British physics it is rare that a man's work should thus be associated with an instrument, though it is common enough to be almost the rule among the great names of American science. Though, in fact, in Aston's case the instrument was devised to test a specific theory and not developed for its own sake, it is yet true that Aston's mind was fundamentally that of an instrumentalist to whom experimental methods and actual manual dexterity are a joy in themselves approaching that to be gained from the results they give. This habit of mind can be traced throughout his life, and the skill of hand that went with it found expression as well in games and in music.

F. W. Aston was born in September 1877 at Tennal House, Harborne, Birmingham, which is still occupied by a member of the family. He was the second son and third child of a family of seven. From an early age he showed a passion for mechanical toys. After a preparatory education at Harborne Vicarage School, he went for two years to Malvern College, where he began the study of science. He left in 1893, head of the school in chemistry and physics and in the highest mathematical set, to enter Mason College, Birmingham. Here he worked under Tilden and Frankland for chemistry, and under Poynting for physics, of whom he often spoke with affection in later years. At Birmingham, too, he laid the foundation of his skill as a glass-blower which was to be so important to him later on. In 1898 he was awarded the Forster Scholarship and worked on the preparation and optical rotatory properties of a complex tartaric derivative, the results of which were published in collaboration with Frankland in 1901. For financial reasons he then took up fermentation chemistry and was engaged for three years at a brewery in Wolverhampton. During this period his thoughts were turning to physics under the influence of the new science that followed the discovery of X-rays. Quite naturally his interest expressed itself in terms of apparatus. He designed and made a new pattern of Sprengel pump, and with it exhausted small focus tubes, made from chemical test tubes, in a tiny workshop at home. The Sprengel pump led to a Tœpler, also of new design, and he discovered a type of rectifying valve depending on a gas discharge.

In 1903 Aston definitely returned to physics, with a scholarship to the University of Birmingham, as Mason College had by then become, where he worked on properties of the gas discharge, in particular of the dark space. His measurements of the length of the Crookes' dark space and its variation with current and pressure are still classical and appeared in the *Proceedings of the Royal Society* of 1905. Two years after, he discovered the narrow region which appears in some gases inside the Crookes' dark space and is known as the 'Aston dark space'. Then came a tour round the world, as the result of a legacy, which confirmed him in a love of travel, and especially of ocean travel, that never left him and was the source of much happiness.

In 1909 Aston took the step which, as it turned out, determined his future scientific career, by accepting the invitation of J. J. Thomson to work as

his assistant in the Cavendish Laboratory, a post which left him time for independent research. By then Thomson had developed the parabola method of analysing positive rays, and produced for the first time clear evidence that atoms and molecules were, at least in certain cases, of definite weights for any particular substance. Besides continuing his own work on the dark spaces and measuring the distribution of force in this region of discharge, Aston helped in the further development of the analysis of positive rays. Among the photographs taken on his improved apparatus were some showing a curious effect with neon. Instead of a single parabola due to the atoms of this gas there were two, corresponding to weights of about 20 and 22 units. Isotopes among radioactive substances were already an accepted fact, due to the work of Soddy, and Thomson, not without some hesitation, attributed the two lines to isotopes of neon. The lines were undoubtedly due to neon, since they only occurred when this gas was present. The alternative was to suppose the weaker 22 line to be due to a compound NeH_2 (in this early work it was practically impossible to get rid of hydrogen). Such a compound was contrary to chemical ideas, but since the method of positive rays had already disclosed several compounds which violated the ordinary laws of valency, the chemical evidence was not very strong, and the decision had to rest on the character of the second line, its variation with conditions, and in particular the appearances of a corresponding line showing a double charge for which there was then no precedent among compounds.

Aston set to work to decide the question. There were two ways of doing so. The first was to try to separate the isotopes if they really existed. The second was to compare the values of e/m of the positive rays with that to be expected from the density of the gas, which gave an atomic weight of 20·2. If the weaker line was due to a compound, the stronger should show a mass of 20·2 ; if to an isotope, the weight 20·2 must be a mean and the stronger line have a smaller mass, probably about 20. The parabola method was not accurate enough to decide between these possibilities.

Aston started with the first, and as we should now think it, the harder method. At first, indeed, he had some slight success, and an ingenious apparatus for fractional distillation, which of course he made himself, had given a positive result just outside the experimental error when the First World War broke out. During this War Aston worked at Farnborough at the Royal Aircraft Factory, as it then was, as a chemist studying the peculiarities of the doped canvas with which aeroplanes were then covered, and its preservation by pigments. All the time, however, he was thinking over the neon problem. He lived in a civilian mess known from its location first as 'Arnold House' and then as 'Chudleigh'. Here he discussed physics and the then new quantum theory in its relation to isotopes with Lindemann (now Lord Cherwell), with results which appeared shortly after the War in two joint theoretical papers in the *Philosophical Magazine*. The 'Chudleigh' atmosphere was conducive to the spread of ideas, among the others who lived there from time to time being Sir Geoffrey Taylor, Sir Melville Jones, F. M. Green, then chief engineer of the Factory, Prof. E. D. Adrian, W. S. Farren, later director of the R.A.E., D. H. Pinsent, a young man of great brilliance killed during an experiment in the air, H. Glauert, and myself. Aston was inclined to be shy in discussing his work, and the ability to do so with men with whom he was really intimate was probably valuable to him. Certainly he always referred to those times with pleasure in after years.

The end of the War brought a great disappointment. Two successive pieces of apparatus designed to achieve the separation of the neon isotopes by diffusion failed to do so. It says much for Aston's faith and courage that he was undeterred by these failures, which must have been particularly hard after his previous partial success. The failures were due, not to any error of principle, but to insufficient mixing in the diffusing bodies of gas.

Aston accordingly turned to plans which he had developed while at Farnborough for an attack on the problem by the second method. He devised the well-known apparatus with which his name is so closely associated, in which the ingenious use of electromagnetic focusing of a special type makes great improvements possible in intensity, dispersion and resolving power. The more delicate parts, such as the slits, of this new apparatus he made himself. The new mass spectrograph, as he called it, was an almost instantaneous success. Not merely did Aston show that neon is indeed a mixture of isotopes, but also that the same is true of chlorine and many other elements.

Aston's discovery was quickly acclaimed. He became a fellow of Trinity in 1920, where he lived ever after until his death. He received the Nobel Prize for chemistry and the Hughes Medal of the Royal Society within two days in 1922 ; he had been elected a fellow of the Royal Society in 1921.

The earlier work with isotopes was done with gaseous compounds, and many of the metals were missing. In order to get beams of metallic ions, special methods have to be used. Dempster in 1921 analysed magnesium, and soon after Aston and I, simultaneously but independently, discovered means of analysing lithium, which was closely followed by many of the other metals of the early groups of the periodic classification. Later on, Aston succeeded in producing beams of ions from most of the remaining elements, even including the rare earths. In all but a few cases he made the first isotopic analysis.

The original mass spectrograph, now in the Science Museum, South Kensington, analysed more than fifty elements during its active career and established the whole-number rule. The task of its successor was to measure the deviations from this rule which are so vitally important in nuclear physics, and in especial for atomic energy.

The new mass spectrograph was accurate to 1 in 10,000. It was characteristic of Aston that to ensure the complete reliability of a battery of 500 small lead accumulators which supplied the field for the deflector plates, he decided to make them himself. He was now concerned with high accuracy, and exerted his ingenuity to devise methods of comparing masses with the utmost precision. These measurements are extremely difficult and in some cases, as might be expected, appreciable alterations had to be made in the results first obtained. By a curious accident a mistake in the ratio of the masses of helium and oxygen stimulated the discovery of heavy hydrogen by Urey and Brickwedde by predicting a larger discrepancy between the physical and chemical atomic weights of hydrogen than in fact exists.

Aston never forgot his early training as a chemist ;

and his next task, that of determining the relative abundance of isotopes, interested him partly because of its connexion with the atomic weights of chemistry. His method was a photographic one, in which exposures were adjusted to make the blackening caused by two isotopes the same or nearly so. His last apparatus, the third mass spectrograph, aimed at an accuracy of 1 in 100,000, and though it did not have quite the resolving power he had hoped for, it achieved valuable results in fixing the mass defects of a number of important isotopes.

Though in the later years, work of equal quality was being done in the field of mass spectrography by Dempster, Bainbridge, Neier and others in the United States, there are few instances in modern science in which the first discoverer of a major field of research has had it so much his own way for such a long time. This is evidence of the technical difficulties involved, not only, or even perhaps mostly, on the measurement side, but also in the production of beams of ions of all sorts of elements with measurable intensity. For this, Aston's training in chemistry and in the peculiarities of the gaseous discharge were of the greatest value. But to this training he added that combination of patience and intuition which marks the great experimenter. There is scarcely a research in nuclear physics which does not use his work, directly or indirectly, and usually many times over. The use of isotopes as tracer elements both in chemistry and in biology is only in its early stage, but even now the results are highly important and it is difficult to put a limit of the possibilities of this field. It is true that most of the isotopes used for this purpose are either radioactive or were discovered by the analysis of band spectra, but the method would scarcely be possible without the knowledge of the isotopic structure of ordinary elements which we owe to Aston. Nor is it likely that the rare isotopes of the light elements, such as heavy hydrogen, which his method is not well fitted to discover, would have been found without his work.

Outside his work Aston's interests were most strongly held by sport, by travel and by music, though any sort of mechanical or scientific device attracted him. In sport he was an ardent skier and made almost yearly visits both to Switzerland and to Norway. He preferred expeditions, often long ones, to trick turns, though he had jumped a little. He liked to do his own climbing and to be independent of funiculars. It was perhaps the greatest grief of his life that a strained heart produced by skiing in the winter of 1934–35 put a stop to winter sports. But skiing was only one of many sports. As a young man he once cycled two hundred miles in twenty-two hours; he was a good lawn tennis player of tournament class, a good swimmer and used to say that the surf-riding he learnt at Honolulu was in many ways the finest sport in the world. He was a golfer well above the average, and the Sunday four with Rutherford, Fowler and Taylor was an institution. During the First World War he took up rock climbing. On several occasions he led courses classed as of 'exceptional severity'. Among his miscellaneous activities were photography, bridge and the special Trinity game of vingt, and the collection of Chinese porcelain. He played the piano and violin, but gave most attention to the 'cello.

His love of travel was intense, especially sea travel, and he contrived to combine it with science by going on eclipse expeditions and on British Association visits, though these were by no means his only journeys.

Aston was a man in whom a great zest for life was combined with a simplicity of character almost approaching naïvety. He was interested in people, especially his numerous friends, and probably more interested in things and places. This gift of interest in the outside world made him an ideal holiday companion. The pleasure he clearly took communicated itself to the rest of the party. He was precise in his habits, though it would be unfair to call him old-maidish, for he enjoyed changing from one routine of life to a totally different one. Though a good occasional lecturer, he had no gift for teaching and a few early attempts were not persisted in. He enjoyed scientific meetings, but was essentially an individualist and never attempted to form a school. I think he realized that much of his skill was incommunicable, and that in any event he needed quiet to work his best. His attitude to physics was essentially that of the experimenter and visualizer. He preferred the model to the equation; the concrete to the abstract. The philosophical aspect did not appeal to him. He was a Conservative in politics as in life, and though he would admit that a change might be good, he preferred it to happen as gradually as possible. I last saw him when he received the Duddell Medal of the Physical Society. In a characteristic speech he remarked with some feeling that his researches would never have been passed by any competent planning committee.

In addition to many papers in the *Proceedings of the Royal Society* and *Philosophical Magazine*, Aston's principal published work was his book on "Isotopes", of which the first edition came out in 1922, the second in 1924. In 1933 the name was changed to "Mass Spectra and Isotopes", though much of the material was the same; in 1941 it appeared in final form. He was twice on the Council of the Royal Society, was awarded a Royal Medal and gave the Bakerian Lecture in 1927. He was an honorary member of the Russian Academy of Sciences, and of the Accademia dei Lincei. He received an Hon. LL.D. from the University of Birmingham, and an Hon. D.Sc. from Dublin. He took a prominent part in the work of the International Atomic Weights Committee.

G. P. Thomson.

Prof. F. Záviška

František Záviška, whose death due to neglect and dysentery occurred on April 17, 1945, a few days after his liberation from the concentration camp at Osterode, was an eminent Czechoslovak theoretical physicist.

Záviška was born on November 18, 1879, in Velké Meziříčí, Moravia, and studied at the Charles University, Prague. After a brilliant career there, he was appointed assistant at the Technical High School in Brno. In 1903 he returned to Prague, where he obtained his doctorate.

Záviška's first important researches were on Fresnel's laws of birefringence and on the polarization of boundary lines of total reflexion. In 1906 he became a *docent* of theoretical physics and obtained a grant which enabled him to proceed to Cambridge, where he worked in Sir J. J. Thomson's laboratory on the influence of X-rays on condensation of water vapour. He returned to Prague, where he successfully worked on the theory of the Hall effect. In 1914 he became a temporary professor, and in 1919 a permanent professor of theoretical physics in the Charles University in Prague.

Záviška's subsequent work was chiefly concerned

with the theory of wave guides and the propagation of electromagnetic waves through tubes. He was popular alike with students and colleagues, and enjoyed the reputation of being a first-class teacher. He worked also on the theory of relativity and published many valuable text-books in Czech for his students. He was admired for the clearness of his lectures and unswerving character.

After the German occupation of Czechoslovakia, he was arrested in 1944, and after being in several concentration camps, he was finally transferred to Osterode. In April 1945 the Germans evacuated the camp, fearing capture by the Allies, and Záviška was in a group of about six hundred who were travelling on foot. The group, however, rapidly diminished owing to continuous shooting of stragglers by the S.S. men; but Záviška was able to escape into a nearby wood. Very ill, he managed to reach some Americans; he was taken into the hospital of Gifhorn, but died there two days later.

VLADIMIR VAND.

WE regret to announce the following deaths:

Dr. J. Brittain, director of research on explosive projectiles, Royal Arsenal, Woolwich, on February 13.

Prof. J. Stanley Gardiner, F.R.S., emeritus professor of zoology in the University of Cambridge, on February 28, aged seventy-four.

Mr. C. M. Lloyd, for more than twenty years head of the Department of Social Science, London School of Economics, on February 20, aged sixty-seven.

NEWS and VIEWS

Sir John Townsend, F.R.S.

SIR JOHN TOWNSEND'S retirement from the Wykeham chair of physics in the University of Oxford after more than forty years of service is an occasion for remarking on his influence on electrical investigations. His best-known researches are, of course, those on the ionization produced by electrons drifting through gases in an electric field, but these represent only one group of many investigations which he and his students have made on the kinetics of charged particles. The experiments and analysis which established the dependence on speed of the mean free paths of slow electrons, which were summarized in a centenary address to the Franklin Institute in 1924, may perhaps be singled out as being particularly brilliant and fundamental. To Sir John also belongs the credit for having shown, at an early stage in the development of the theory of ionization, that the production of electric sparks can be accounted for in terms of other properties of the conducting gas, and for having insisted that the breakdown voltage may be lowered by volume electrification. Many of the most interesting extensions of his work have been made in the United States, and include K. T. Compton's theory of the cathode dark space, I. Langmuir's theory of the effect of a magnetic field on a discharge plasma, and Loeb's critique of the whole range of phenomena related to sparking. A great deal of the work initiated or inspired by Sir John, such as Kirkby's, on the combustion of hydrogen in a discharge, and MacCallum's, on the helium molecule, still remains, however, to be worked out in detail. Physicists the world over will join in extending their best wishes to Sir John Townsend, and in expressing the hope that retirement will not involve a cessation of his active interest in the field which he has so largely made his own.

Prehistoric Archæology in the University of London: Prof. V. Gordon Childe

THE announcement that Prof. Gordon Childe has been appointed to a newly created chair of prehistoric European archæology at the University of London was not unexpected and will be welcomed. Prof. Childe is one of the leading British archæologists, and his influence will be still more largely felt when he gets into the saddle in London. Born in Australia, he took his degree at Oxford, and then, after a period in Australia, returned to Britain and acted as librarian to the Royal Anthropological Institute. Later he went to Edinburgh on becoming the first Abercromby professor of archæology there. While in London he had already made his name through his books, "The Dawn of European Civilisation" and "The Danube in Prehistory". From Edinburgh there followed "New Light on the Most Ancient East", a work which has enabled prehistorians readily to absorb the latest ideas on Near Eastern archæology. Scotland, too, has not been forgotten, as the publication of his own excavations at Skara Brae bears testimony. More recently, Prof. Childe has tended to concentrate on making his great knowledge available for the ordinary intelligent reader, and a number of small works, including one in the Pelican Series, have issued from his pen. Prof. Childe has not merely worked in his study. He has travelled extensively and undertaken excavations in the field. His influence on British archæology has been considerable and archæologists will be glad to have him once more in London.

Financing Research in Industry

WHEN Lord Barnby withdrew his bill to enable the Board of Trade to impose a statutory levy to finance research in industry last autumn, it was stated that the Government would take the earliest opportunity to see whether other proposals of the same kind could be tried. The matter was raised in the House of Commons in the committee stage on the Emergency Laws (Transitional Provisions) on January 23, when Sir Stafford Cripps moved an amendment to include a regulation, Defence (Services for Industry) Regulations, 1945, to enable the Board of Trade, should it be so desired, after consultation with any particular industry or branch of industry, to make arrangements for securing co-operative provision within that industry for certain facilities including research and experiments in matters relating to manufacture, consumption, collection and publication of statistics and other services conducing to increased efficiency in production and marketing of products. In explaining the purpose of the regulation, Sir Stafford Cripps stated that its inclusion would give the Government eighteen months or more to find out whether industries desired this method of levy for co-operative service, so that there would be time to draft a more permanent form of legislation which might be required. The proposed collective action is limited to research, market research, the collection of statistics and such matters,

with a financial limit of £500,000, and no such levy can be made without the consent of a large part of the industry concerned and without an order being placed before the House of Commons.

The discussion on this proposal in the House of Commons, owing to the heading under which it occurred, appears to have escaped the attention of scientific workers generally, but the criticism voiced in the House was raised rather at the manner in which the proposal was included in the bill, and particularly that the order had not then been seen by the majority of members present. There was general agreement as to the importance of research and the need for going ahead with the organisation of research, even though a larger supply of scientific men and engineers might be required to implement such developments; but some emphatic protests were registered against the procedure adopted in the matter by the President of the Board of Trade before the proposal was adopted on division. A 'prayer' to annul the order was defeated in the House of Commons on February 19.

Statistics of Industrial Production in Britain

THE publication of the first number of the *Monthly Digest of Statistics* (London: H.M. Stationery Office. 2*s*. 6*d*. net) is the first step towards the issue of British industrial production statistics since publication was stopped early in the War. Some of the figures have been given elsewhere in the White Paper on the war effort, but for the first time there is made available to the general public in one document a wide range of production, consumption and stocks statistics in non-monetary terms. The *Digest* has been prepared by the Central Statistical Office in collaboration with the statistics divisions of Government departments, and the aim is to provide in summary form statistics which show the changing pattern of the economic activity of Britain. All the statistics are presented in the form of time series, and figures are given, so far as possible, for each of the calendar years 1935–44, and monthly since the beginning of 1944. The scope of the *Digest* will be revised from time to time to include new statistical information as it becomes available. A supplement, published separately, gives in detail the definitions of the items and units employed. As arranged at present, the *Digest* consists of eleven sections covering, respectively, employment, fuel and power, raw materials, manufactured goods, building, agriculture and food, external trade, merchant shipping, inland transport, finance, and wages and prices. In the sections on raw materials, manufactured goods, building and agriculture and food, the figures provided vary widely in extent. For papermaking materials the data given are as much as could be desired, but figures for the chemical industries are almost completely absent, and no figures at all appear for stocks of food, iron and steel or timber. These are important omissions, and while the *Digest* is to be welcomed as a start towards providing the statistical material which is imperatively required for further research, and which the Government has repeatedly promised, it will require many additions before it fully meets the demand or honours that promise.

Medicine and Surgery during the Renaissance

SIR ARTHUR MACNALTY delivered the Thomas Vicary Lecture at the Royal College of Surgeons on November 1. The life of Thomas Vicary, Serjeant-Surgeon to four Tudor monarchs, Master of the Barbers Company, four times Master of the Barber-Surgeons Company and Surgeon to St. Bartholomew's Hospital, was passed in stirring times. He experienced the influence of the Renaissance and the birth of freedom of thought, individual initiative and action which guided him in his work for British surgery. The heritage of Greek thought was brought to England by a band of Oxford men, Linacre, Grocyn, Thomas Latimer and Colet. Erasmus lectured at Oxford and Cambridge, and Corpus Christi College, Oxford, was founded in the interests of the new learning. A general account was given of Tudor England, followed by a review of the education of those days. The medical student received a reasonable general education, particularly if he went to the university before entering on his professional studies. In Henry VIII's reign the beginnings of an enlightened public health policy can be traced, especially in regard to the improvement of water-supplies. There was much disease. Syphilis was a deadly scourge, leprosy still lingered, measles, smallpox, tuberculosis, typhus and dysentery prevailed. The deadliest epidemics were bubonic plague and the sweating sickness, which has been identified with the 'Picardy Sweat' of the eighteenth and nineteenth centuries.

A tribute was paid by Sir Arthur to three Tudor pioneers in public health, Sir Thomas More, Sir Thomas Elyot and Dr. Andrew Boorde. Sir Thomas More applied his learning in Greek medicine and experience in health administration to a description of the provisions for public health which were necessary in 'Utopia'. We have to wait until the nineteenth century for a man of equal vision and breadth of view to appear in Edwin Chadwick. The hospitals of England, despite Sir Thomas More's protests, were abolished in the dissolution of the monasteries. Through the efforts of the City Corporation, the five 'Royal Hospitals', St. Bartholomew's, St. Thomas's, Christ's Hospital, Bethlem Hospital and Bridewell, were preserved in London. It was also shown how Linacre, by founding the College of Physicians, and Vicary, by uniting the Corporation of Surgeons with the Barber-Surgeons, established medicine and surgery as learned professions. They thus opened the doors to the light of the Renaissance and taught the value of independent thought, experiment and observation. In medicine, surgery and public health, the Renaissance in England was not a time of building but of laying foundations well and truly on which a future edifice was to arise—not a time of harvest but a time in which the seeds of knowledge were sown.

Biologists in Czechoslovakia during the War

IN a communication to Sir E. J. Salisbury, director of the Royal Botanic Gardens, Kew, the director of the National Museum, Prague (Dr. S. Prát), has described the war damage to the Museum and other scientific institutes and various effects of the War on Czechoslovakia. Some revealing photographs of damage to buildings were also sent. According to Dr. Prát, he and his colleagues were completely isolated during the War, and they were unable to do any scientific work. The schools were closed and the laboratories were occupied by Germans. Work is now starting again at the National Museum, which was little damaged. Fortunately most of the equipment was saved. Prof. J. Kořínek is in charge of the microbiology laboratory, and Dr. K. Hrubý is restoring the genetics laboratory. Devastation of

Prof. V. Úlehla's buildings at Brno was heavier and it is doubtful if he will be able to start work again for some time.

University Graduates in Industry and Commerce

It is a welcome sign that both the universities and industry in Britain are becoming each more aware of the importance of the one to the other. On February 23 a joint conference of the Association of University Teachers and of the Confederation of Management Associations was held in London under the chairmanship of Mr. Clifton Robbins, director of the London Office of the International Labour Office. Among the matters discussed were the widening of the activities of university appointments boards, the possibilities of post-graduate courses, and the desirability of taking an external degree while doing a part-time job. A verbatim report of the proceedings is being prepared which, on the proposal of the chairman, will be used by a working committee composed of three university teachers and three business managers in the preparation of a report for consideration by a further wider conference with the view of arriving at constructive practical proposals.

British Council Scholarships

For the current academic year, more than three hundred British Council scholarships for study in Britain have been awarded to students from overseas. These scholarships, normally for one year with extensions in special cases, are granted to post-graduates and others of similar standing. For this year a considerable number of scholarships has been awarded to students from European countries which were cut off from Britain during the War. Most of the students are in universities and colleges, but some are training in engineering and other industrial plants. During the vacations, tours and summer schools are arranged to ensure that the knowledge of Britain gained by the students is extended beyond the places where they are studying. The scholarship-holders have come from forty-five different territories in the Empire, Europe, Latin-America, the Near and Far East. Subjects, with the numbers taking each, include: agriculture 17, building 2, chemistry and pharmacology 13, economics 22, engineering 47, education 29, geology 1, history and anthropology 10, mathematics 6, medical subjects 43, meteorology 2, philosophy 2, sciences 3, veterinary science 4.

Royal Society of Edinburgh: New Fellows

The following have been elected ordinary fellows of the Royal Society of Edinburgh: Dr. W. M. Ames, works manager and chemist, Messrs. J. and G. Cox, Ltd., Edinburgh; Brigadier E. W. S. Balfour, Balbirnie, Markinch, Fife; Prof. G. F. Boddie, Department of Medicine and Pharmacology, Royal (Dick) Veterinary College, Edinburgh; Prof. D. F. Cappell, Department of Pathology, University of Glasgow and pathologist to Glasgow Western Infirmary; Dr. H. C. Choudhuri (formerly research worker, University of Edinburgh), Nator, Rajshahi, Bengal; Dr. R. P. Cook, lecturer in biochemistry, University of St. Andrews, University College, Dundee; Prof. P. I. Dee, Department of Natural Philosophy, University of Glasgow; Dr. R. F. J. Fairlie, architect, Edinburgh; Prof. Norman Feather, Department of Natural Philosophy, University of Edinburgh; Dr. H. S. D. Garven, late professor and vice-principal, Mukden Medical College, Manchuria; Dr. Duncan Leitch, lecturer in geology, University of Glasgow; Prof. Stuart McDonald, jun., Department of Pathology, University of St. Andrews; Dr. D. S. MacLagan, head of Zoology Department, West of Scotland Agricultural College, Glasgow; Prof. A. C. Offord, Department of Mathematics, University of Durham (King's College, Newcastle-upon-Tyne); Mr. James Paton, lecturer in meteorology, University of Edinburgh; Dr. Guido Pontecorvo, lecturer in genetics, University of Glasgow; Prof. A. D. Ritchie, Department of Philosophy, University of Edinburgh; Prof. A. Robertson, Department of Hygiene, Dietetics and Animal Husbandry, Royal (Dick) Veterinary College, Edinburgh; Rev. A. E. Robertson, minister of the Church of Scotland, Edinburgh; Prof. R. L. de C. H. Saunders, associate professor of anatomy, Department of Anatomy, Dalhousie University, Halifax, Nova Scotia; Dr. A. G. Walker, lecturer in pure mathematics, University of Liverpool; Mr. William Wallace, president of the Edinburgh Chamber of Commerce and Manufactures, Edinburgh; Mr. A. R. Waterston, assistant keeper, Natural History Department, Royal Scottish Museum, Edinburgh; Mr. T. H. Whitehead, assistant to the Director (Scotland), Geological Survey and Museum, Edinburgh; Dr. H. Wood, senior naturalist in the Fisheries Division of the Scottish Home Department, Aberdeen.

Announcements

Dr. J. A. V. Butler has been appointed Courtauld research fellow in the Courtauld Institute of Biochemistry, Middlesex Hospital Medical School, London, where he will be in charge of a unit which is to investigate the physical and chemical properties of biologically active and other proteins. Dr. Butler has been a lecturer in the Chemistry Department of the University of Edinburgh since 1927; he held a Rockefeller fellowship in Dr. Northrop's laboratory in the Rockefeller Institute for Medical Research, Princeton, N.J., during 1939–41, and during 1941–44 he was executive officer to the British Central Scientific Office, Washington.

Dr. J. Allen, lecturer in engineering in the University of Manchester, has been appointed Jackson professor of engineering in the University of Aberdeen.

The Council of the Royal Society of Edinburgh has awarded the Keith Prize for the period 1941–45 to Dr. William Leonard Edge, University of Edinburgh, for his work in geometry, and particularly for his papers published in the *Proceedings* of the Society within the period of the award; and the Neill Prize (1943–45) jointly to Mr. J. G. Carr, Institute of Animal Genetics, University of Edinburgh, for his contributions to our knowledge of tumour viruses in animals; and to Dr. Ethel D. Currie, University of Glasgow, for her paper on "Growth Stages in Some Jurassic Ammonites" published in the *Transactions* of the Society within the period.

Emde's "Tables of Elementary Functions" was noticed in *Nature* of February 23, p. 209. The sole British agents for this work are the Scientific Computing Service, Ltd., 25 Bedford Square, London, W.C.1, and the English price is £1.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

A Lunar Effect on Cosmic Rays ?

As reported in previous communications, hourly records of cosmic ray intensity have been made in London during the past few years by registering threefold coincidences between three trays of Geiger-Müller counters.

The harmonic analysis of the average solar daily inequalities for the period May 1941–April 1944 revealed, besides the well known 24-hour wave, the existence of a physically significant semi-diurnal variation, S_c, nearly opposite in phase to the semi-diurnal oscillation of the barometer, S_p :[1]

$$S_c = 0{\cdot}14 \sin (2t - 6°) \text{ in percentages of the mean,}$$
$$S_p = 0{\cdot}22 \sin (2t + 144°) \text{ in millimetres of mercury,}$$

where t represents the measure in angle of Greenwich mean solar time. It was also found that the seasonal changes of these two waves follow each other closely.

Taking into account that the solar semi-diurnal oscillation of the atmosphere is partly tidal in character, these results led me to conclude that the semi-diurnal variation of cosmic-ray intensity could be explained by the motion up and down of the meson-producing layer, which is in phase with the atmospheric oscillation. It would be sufficient for this oscillation to be about ten times greater in the region where mesons are formed than at sea-level. (This point has been discussed more fully in my Guthrie Lecture.)

In the light of these results, it was thought of interest to ascertain whether the lunar atmospheric tide has any appreciable effect on the intensity of cosmic rays. To ascertain this, the data for 856 complete days of the period mentioned above have been used. The total number of coincidences recorded during this number of days amounts to 550 millions. From these data, following the method developed by Chapman and Miller[2], a lunar semi-diurnal variation of the cosmic ray intensity, L_c, is found which is expressed by

$$L_c = 0{\cdot}023 \sin (2\tau + 160°) \text{ in percentages of the mean,}$$

where τ denotes Greenwich mean lunar time in angle. The probable error is 0·011 per cent, half that of the amplitude. Thus this variation might be regarded as physically significant, although the present determination is not very accurate.

If we take L_c as real and assume that it is due to the vertical motion of the meson-producing layer in phase with the lunar tide, then from the ratio

$$(S_c/L_c)_{\text{amplitude}}$$

which is equal to 6, we conclude that in the region where mesons originate the solar oscillation is six times greater than the lunar tide. Since the lunar tide for Greenwich at ground-level is, as determined by Chapman,

$$L_p = 0{\cdot}009 (2\tau + 114°) \text{ mm. mercury, then } (S_p/L_p)_{\text{ampl.}} = 24.$$

Consequently, $L_c/L_p = 4S_c/S_p$, that is to say, the lunar tide must increase with height more quickly relatively than the solar oscillation.

This implication accords with results obtained by other means. Pekeris[3] has found from this theory that the vertical motion of air particles due to the solar oscillation in the ionosphere should be 130 times greater than at sea-level, while Appleton and Weekes[4] found experimentally a lunar tide in the Kennelly-Heaviside layer of the order of 1 km., which is 7,000 times greater than the tide at the ground.

Again, the fact that L_c is less than S_c, while the lunar tide in the ionosphere appears to be several times greater than the solar oscillation, indicates that mesons originate well below that region, a result also in accordance with present views.

It is therefore possible that the moon, by altering the height of the meson-producing layer, appreciably affects the intensity of cosmic rays as measured at the ground.

A more detailed account of this investigation will be published shortly.

A. Duperier.

Department of Physics,
Imperial College of Science and Technology,
South Kensington.
Nov. 8.

[1] Duperier, *Proc. Phys. Soc.*, **57**, 464 (1945).
[2] Chapman and Miller, *Mon. Not. Roy. Ast. Soc., Geophys. Supp.*, **4**, 649 (1940).
[3] Pekeris, see Appleton and Weekes (ref. 4, p. 186).
[4] Appleton and Weekes, *Proc. Roy. Soc.*, A, 171, 171 (1939).

Cosmic Ray Absorption Underground

As part of our cosmic ray programme, we had occasion to measure the absorption in lead of the radiation in a vertical direction on Holborn Underground Tube Station during the years 1937–39. While this work was going on, results of similar measurements underground were published by other workers[1]. Our work was left unpublished due to the pressure of war activity, but in view of the fact that very few measurements have been made underground, we think the results obtained are worth recording.

Thanks to the co-operation of the London Passenger Transport Board, the measurements were performed in a tunnel, 30 metres under London clay. The general layout of the apparatus with respect to the surroundings is shown in Fig. 1, which shows a telescope of four Geiger-Müller counters on a table, standing on a platform in the tunnel.

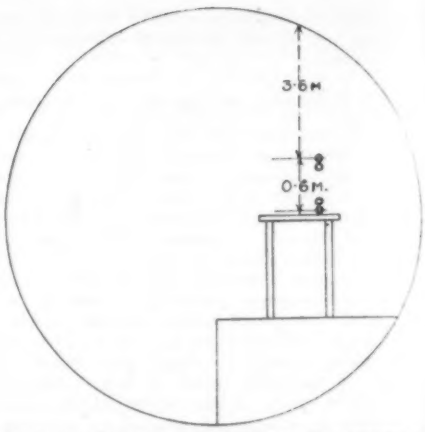


Fig. 1. Disposition of absorption counter arrangement underground. Counters 3 cm. × 40 cm.

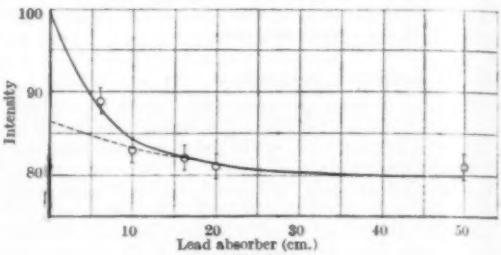


Fig. 2.

The absorption curve obtained is shown in Fig. 2, the dotted curve being the extrapolation of the hard component back to zero thickness. The amount of soft component thus deduced is 14 per cent, and the mass absorption coefficient of the hard component is found to be $1{\cdot}5 \times 10^{-4}$ cm.^{2}/gm.

While the results of all workers on the absorption coefficient may be regarded as mutually consistent, the same cannot be said of the proportion of soft component. Results for the soft component measured underground have varied from 5 to 25 per cent of the total intensity. This wide variation is due to differences in the geometry of the apparatus of the various workers ; and it is felt that before any assessment of this factor can be made, it is necessary that the arrangement of the apparatus be given, if possible, for the previous work, and certainly for any future measurements that may be made.

E. P. George.

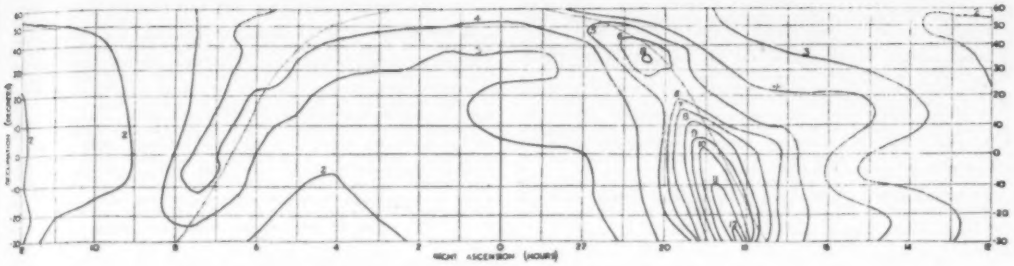
Birkbeck College,
University of London,
London, E.C.4.
Nov. 29.

[1] Morgan and Nielsen, *Phys. Rev.*, **54**, 245 (1938). Wilson, *Phys. Rev.*, **53**, 337 (1938). Auger, *J. Phys.*, **6**, 253 (1936).

Cosmic Radiations at 5 Metres Wave-length

The discovery of electromagnetic 'noise' radiations at radio frequencies was first made by K. G. Jansky[1] who, in a series of measurements at about 20 Mc./s. ($\lambda \simeq 15$ m.) was able to establish the close connexion between the direction of greatest intensity and the centre of the galaxy. G. Reber[2] later made measurements at 160 Mc./s. ($\lambda \simeq 2$ m.), and he was able, by virtue of a narrower beam, to detect a number of subsidiary peaks. He found the intensity of radiation at this higher frequency was very much less ; he also suggested a probable explanation of the radiations, namely, the interactions in encounters between positive ions and free electrons released from interstellar gases by the photo-electric action of stellar radiations. The theoretical treatment for radiation arising from such encounters was first given by H. A. Kramers[3] to account for continuous radiation in X-ray spectra. The cosmic noise radiation is not observable at frequencies lower than a few megacycles per second, owing to the screening action of the ionosphere.

It appears important from the point of view of both astronomical and radio research to determine the distribution and intensity of the source in detail at various frequencies. The main practical difficulty is that, unless an unwieldy aerial system is used, the cosmic-noise power received is small compared with receiver noise at short wave-lengths of the order of 1 m., while at longer wave-lengths of the order of 10 m., the beam width is too wide for accurate study of the distribution. A compromise between these two factors has



DISTRIBUTION OF INTENSITY OF COSMIC NOISE POWER FLUX AT 64 MC./S.

Unit of power flux on contours = $1{\cdot}1 \times 10^{-21}$ $\Delta\nu\Delta\omega$ watts per sq. m. ($\Delta\nu$ is band width, c./s.; $\Delta\omega$ is element of solid angle, steradians); cylindrical projection; galactic equator, ...

been made by us in a recent investigation at 64 Mc./s. ($\lambda \simeq 5$ m.). A radio receiving equipment with a Yagi aerial system provided a beam width to half-power of approximately $\pm 6°$ in elevation and $\pm 15°$ in bearing. The shape of the polar diagram was established by measurement using a small oscillator on a balloon. The maximum of the beam was at a fixed elevation of 12°, but the equipment could be rotated to any bearing. Calibrated measurements of the received noise signal were made during the period July 22–31, 1945, after a series of preliminary observations during the previous seven weeks had established periodicity in sidereal time and the absence of any marked solar influences.

The cosmic noise was recorded through 360° of bearing at each half-hour during the period of observation. To enable a detailed distribution of the source to be derived, the results were then analysed by the following method, not previously used in cosmic noise investigations. The observed distribution at the receiver for a given sidereal time was first plotted along a circle traced on the celestial sphere by the radio axis during a 360° rotation of bearing. Knowing the characteristics of the aerial beam, it was then possible to deduce a distribution along this circle which would, when integrated over the whole aerial beam, satisfactorily fit the observed intensities at the receiver. This was repeated for different sidereal times, and the intersecting circles then formed a lattice, from which contours could be drawn for the derived distribution of the source of cosmic noise between declinations $-30°$ and $+60°$, as shown in the accompanying figure. The contours are seen to be roughly symmetrical with reference to the galactic equator. The main source of cosmic noise at approximately R.A. 1815 hr., Dec. $-30°$, in the region Scorpio–Sagittarius, corresponds closely to the direction of the galactic centre, while a second marked peak (near one noted by Reber) occurs at R.A. 2030 hr., Dec. $+35°$ in Cygnus. The intensity in the region of the peak in Scorpio–Sagittarius was deduced to be $13{\cdot}2 \times 10^{-21}$ $\Delta\nu\Delta\omega$ watts/sq. metre, where $\Delta\nu$ is the band-width in cycles per sec. and $\Delta\omega$ the element of solid angle subtended in steradians.

J. S. HEY.
J. W. PHILLIPS.
S. J. PARSONS.

Ministry of Supply,
London, S.W.15.
Jan. 28.

[1] Jansky, K. G., *Proc. Inst. Rad. Eng.*, **20**, 1920 (1932); **21**, 1387 (1933); **25**, 1517 (1937); **27**, 763 (1939).
[2] Reber, G., *Proc. Inst. Rad. Eng.*, **28**, 68 (1940); *Astrophys. J.*, **91**, 621 (1940); *Proc. Inst. Rad. Eng.*, **30**, 367 (1942); *Astrophys. J.*, **100**, 297 (1944).
[3] Kramers, H. A., *Phil. Mag.*, **46**, 836 (1923).

Solar Eruption of February–March, 1942

MR. J. S. HEY'S recent report[1] on excessive solar radiation in the 4–6 metre band observed on February 27–28, 1942, and Prof. F. J. M. Stratton's enumeration of associated observations[2] invite a reminder of two other exceptional features of the solar activity on the same occasion.

According to Prof. A. Duperier[3] the magnetic storm of March 1, 1942, provided a most remarkable example of world-wide changes in cosmic ray intensities. The decrease began shortly before the onset of the magnetic storm and reached the unusually high value of about 11 per cent.

Observing the coronal emission lines above the big limb eruption on February 21, Waldmeier[4] noted that the 5694 A. line, usually very faint, had an intensity about three times that of the green line, 5303 A., the latter being itself considerably enhanced. The outburst of the yellow line thus acted as the signal of solar activity with prominent terrestrial consequences. Unfortunately, the origin of 5694 A. is still uncertain. The tentative identification with Ca XV requires that a second line with similar characteristics should appear in the visible region[5].

BENGT EDLÉN.

Physics Institute, University of Lund,
Lund.
Feb. 7.

[1] *Nature*, **157**, 47 (1946).
[2] *Nature*, **157**, 48 (1946).
[3] Guthrie Lecture 1945; *Proc. Phys. Soc.*, **57**, 472 (1945).
[4] *Z. Astrophys.*, **21**, 281 (1942).
[5] Edlén, B., George Darwin Lecture 1945, *Mon. Not. Roy. Ast. Soc.*, in the press.

Preparation of Synthetic Quartz

THE extensive use of quartz in piezoelectric oscillators has stimulated the production of synthetic quartz crystals. Spezia[1] in 1906 grew quartz at a temperature somewhat below 300° C. from an aqueous solution containing sodium metasilicate and sodium chloride. His method was to dissolve quartz in the hotter part of the container and deposit it in the cooler part. We have repeated Spezia's experiments so far as to confirm his results, but the period of months which is required for appreciable growth to occur makes the method unsuitable for industrial production.

We have found that fused silica is mainly converted into quartz when heated in a solution of sodium metasilicate at a suitable temperature. Some of the crystals obtained in this way are perfect but very small. The primary rhombohedron $\{10\bar{1}1\}$ tends to be better developed than the rhombohedron $\{10\bar{1}\bar{1}\}$. The prism faces $\{10\bar{1}0\}$ are also well developed. The form of the fused silica rod was usually preserved, many cavities filled with quartz crystals being found inside. When a natural quartz crystal was suspended by silver wire in the neighbourhood of the fused silica and a suitable mineralizer added to the solution, we found the silica rod dissolved almost completely and an appreciable growth of the seed crystal was obtained in a period of hours. As a rule the natural rhombohedral faces developed more smoothly than the prism faces, which were often rather drusy. Generally the positive rhombohedron faces were smooth and glassy clear, but closer inspection often revealed them to be like shingled roofs, and the individual shingles appeared to consist of layers which had grown out from centres of growth distributed at more or less regular intervals over the surface. The lattice spacings of the synthetic quartz are not distinguishable from those of the natural crystals on an X-ray powder photograph taken in a camera of 19 cm. diameter.

This work, of which a fuller account will be published later, has been done in co-operation with the Research Laboratories of the General Electric Company, Ltd., Wembley, and we are grateful to the director for permission to publish.

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[1] Spezia, G., *Atti. R. Accad. Sci. Torino*, **41**, 158 (1906).

Dielectric Constants of Some Titanates

IN a recent issue of *Nature*[1], B. Wul and I. M. Golgman refer to investigations in the U.S.S.R. on the dielectric properties of some titanates. Secrecy restrictions have previously prevented the publication of other work on the same subject.

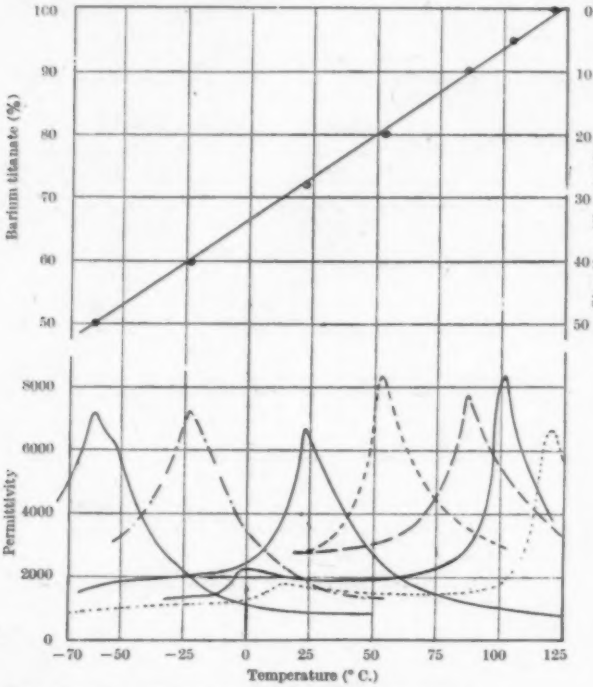
Especially during the last four years have extensive studies been made in our research laboratories, working in collaboration not only to explore the best methods for preparing and fabricating materials of this type on a factory as distinct from a laboratory scale, but also to investigate their electrical and physical properties and to develop therefrom practical forms of electrical condensers utilizing those special properties. We discovered during 1942 that the introduction of alkaline earth or certain other metallic titanates in lieu of titanium dioxide into ceramic dielectric bodies (obtained by firing the ceramic mix at around 1,350° C.) raised the permittivity to much higher values than had previously been known.

In all such bodies we found that the permittivity is subject to very large changes with temperature, and that it reaches a maximum value at some temperature which is characteristic of the material itself. A permittivity peak of approximately 8,000 has been observed for barium titanate at 125° C., and it is believed that calcium titanate and strontium titanate reach similar peaks at temperatures below $-200°$ C. It has also been proved that the value of the peak permittivity is a function *inter alia* of the firing conditions under which the ceramic body has been produced. Some specimens have been prepared with peak permittivities greater than 10,000, one having reached 44,000. These extreme figures, however, are not representative of practical forms of good ceramic dielectric material, since they are accompanied (at least at present) by other less favourable electrical properties, such as lower resistivity and high power-factor. The specimen just mentioned, having a peak permittivity of 44,000, exhibited a resistivity of 10^8 ohm cm. and a power-factor ($\tan\delta$) of 14·6 per cent at 1 kc./s. and 20° C., which may be compared with values of 1 to $1{\cdot}5 \times 10^{12}$ ohm cm., and less than 2 per cent as representative at the same temperature of specimens showing more normal peak permittivities of 7,000–8,000. The figures quoted are found to

vary only slightly over audio frequencies from 1 kc./s. up to radio frequencies. The shape of the permittivity-temperature curve, however, is modified at the lower audio frequencies, and markedly so at zero frequency (D.C. or static capacity). The permittivity of many of these materials is a function also of the voltage stress applied to them whether alternating or unidirectional.

Solid solutions of two or more metallic titanates exhibit similar dielectric properties, but the temperature at which the peak permittivity occurs varies with the composition of the mixture. The accompanying graph illustrates some typical test results for a few such solid solutions of strontium and barium titanates and demonstrates (see upper curve) a linear connexion between the composition and the temperature of the peak permittivity[2].

The investigations have also shown that the shape of the permittivity-temperature curves can be modified by the addition of other materials than the titanates to the ceramic mix. Notably one or more metallic



oxides, in small quantities, which act either merely as diluents and so reduce the effective permittivity values, or in suitable proportions may act as modifying agents to alter the shape of the curves. Zirconia with one or more other metallic oxides may be particularly mentioned[3].

The temperature coefficient of capacitance of capacitors containing these dielectrics can be chosen at will for a predetermined temperature range to be either positive or negative, dependent upon the temperature of the peak permittivity as compared with the operating temperature. They can thus be employed for compensating the effects of temperature changes on the parameters of oscillatory circuits, with the advantage over previously known materials of having much larger temperature coefficients and so permitting the use of smaller capacitances for equivalent effects. As an example, a mixture of 60 : 40 per cent of strontium and calcium titanates has been found to have a nearly linear capacitance-temperature relationship over the working range of − 40° to + 80° C., having a coefficient of − 2,620 × 10^{-6}/° C. over that range.

Within the last few weeks reports have reached us showing that a somewhat similar series of investigations has also been in progress for some time past by the Titanium Alloy Manufacturing Company in the United States. Fuller accounts of our work will be published later.

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[1] *Nature*, **156**, 480 (1945). See also *C.R.* (*Doklady*) *Acad. Sci. U.R.S.S.*, **46**, No. 4, 139 (1945).
[2] An analogous relationship has been shown by Prof. Willis Jackson and Mr. Reddish in a communication which has appeared since this was written: *Nature*, **156**, 717 (1945).
[3] Others are cited in our British Patent Application No. 17468/1942 (not yet published owing to security restrictions).

Electrode Evaporation and the Electric Spark

In accordance with the Similarity Theorem, the electric spark discharge at high gas densities (such as those corresponding to atmospheric pressure or more) takes the form of a thin track, so that the use of high gas densities can produce high current densities. It is therefore interesting to calculate the actual order of magnitude of the current density in typical sparks, in order to find whether high current densities can produce any important effects on the electrodes.

In many practical applications of spark gaps, such as those in various electronic devices, safety gaps, and the sparking plugs of internal combustion engines, the peak current in the initial spark breakdown is of the order of 100 amp., but to find the current density at the electrodes it is necessary to find the cross-sectional area of the current there. I have made theoretical estimates of these areas from a consideration of the lateral diffusion of the electrons and ions as they cross the gap, and the calculations, which will be given elsewhere, show that for a typical 0·5 mm. gap at three atmospheres pressure the area is of the order of 10^{-4} cm.^{2}. Thus, with a peak current of 100 amp., the current density in a typical spark gap can attain values of the order of 10^6 amp./cm.^{2} at these small areas, which must consequently become very hot. This estimate is in accordance with recorded values[1] of 8×10^6 amp./cm.^{2} found for gaps rather longer than those considered above.

The suggestion that the local temperatures produced at these hot spots is sufficient to evaporate some electrode material then naturally follows, and this view is supported by the fact that evaporation has in fact been recorded. For example, the vapour of the electrode material has been observed spectroscopically at short intervals during the spark process[1]. Also, the spectrum of the gas through which the spark passes has been examined, and it was found that the gas spectrum was followed by the 'spark' spectrum of the electrode material[2]. Again, it has been shown that spark breakdown can be followed by an arc in the metallic vapour produced by the evaporation of the electrode[3]. Consequently, it is necessary to consider in some detail the important part which electrode evaporation can play in the energy balance at the electrode hot spot, and then to investigate whether this process can be responsible for the observed erosion of the electrodes in the high-pressure spark discharge.

Now cathodic sputtering produced by the low-pressure glow discharge in hydrogen has been investigated by von Hippel[4] and by Guntherschulze[5], who identified two types of sputtering, namely, electrochemical and normal sputtering. The mechanism of the electrochemical process involved chemical combination between the gas atoms and those of the metallic electrode to form compounds which distil off, thereby causing loss of electrode material. Similarly, in the high-pressure spark it may be assumed that the two types of erosion process can take place: one which depends on the chemical reactions between the gas atoms and the electrode, and the other which depends on the release of energy at the electrode by the impact of the electrons and positive ions from the spark. In gases inert to the electrode material, electrochemical effects may be neglected; and if it be assumed that the normal erosion process is in fact evaporation produced by the almost instantaneous release of energy by the spark breakdown, then a relation can be established between the volume v of electrode material which is eroded by a given type of spark and the physical properties of the material. The relation found is:

$$v = \frac{V^2 f(C) - \{aT^4 + bK\,(T - c)\}}{d\,\{(T - c)\,S + 21T/M\}}$$

where T is boiling point of the material (in degrees absolute); d is density; K is thermal conductivity; S is specific heat, and M is molecular weight of the material; V is sparking potential of the gap; $f(C)$ is a function of the constants of the spark circuit; a, b, c are constants of the experimental lay-out. Hence, to obtain the lowest normal erosion rates with a given type of spark the electrodes should, according to this equation, be composed of a material with the highest boiling point, density, and thermal conductivity; the observed low erosion rates of metals like platinum and tungsten, for example, are thus accounted for.

There are other deductions from the erosion equation which are of practical interest. For example, the great influence of the value of the sparking potential is indicated, and this is of importance when considering erosion due to sparks produced by an impulsive E.M.F., because it follows that any increase in the statistical time lag of the gap (by increasing the E.M.F. at breakdown) then results in an increased rate of erosion.

The equation has been applied to experimental data[6] obtained with a number of short spark gaps using different electrode materials employed in the sparking plugs of aero engines; it was found that there was good agreement between the observed relative erosion-rates of the various materials and the relative rates calculated from the erosion equation above. This fact may be taken as evidence in support of the initial assumption that normal erosion at high gas densities may be attributed to the evaporation of the electrode material due to the very rapid release of energy at the hot spot during the initial spark breakdown. Using experimental data on erosion, it was also found possible to make an estimate of the fraction of the total energy of the spark which is dissipated at the electrodes. In the gaps used, only about 10 per cent of the total spark energy was actually liberated at the electrodes: the remaining 90 per cent was absorbed in ionization, excitation and atomic collisions in the gas.

The derivation and a fuller discussion of the erosion equation will be given elsewhere.

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[1] Lawrence and Dunnington, *Phys. Rev.*, **35**, 24 (1930).
[2] Beams, *Phys. Rev.*, **35**, 400 and 404 (1930).
[3] Snoddy, *Phys. Rev.*, **37**, 1678 (1931).
[4] v. Hippel, *Ann. Phys.*, **80**, 7, 672 (1926).
[5] Guntherschulze, *Z. Phys.*, **38**, 8, 563 and 575 (1926).
[6] Debenham and Haydon, Aero. Res. Com. Tech. Report. R. and M., 1744 (1936).

Heat Treatment of Sodium Chloride Windows to Increase Resistance to Atmospheric Action

INFORMATION has recently been obtained from Germany regarding a process used there for heat treatment of optical components made of sodium chloride.

The process consisted in heating the finished components for a few hours at 500° C. The firm believed that the treatment caused a surface flow, resulting in the removal of microscopic scratches left by the polishing process. The resulting smoother surface offered less opportunity for the etching action of water vapour when the components were exposed to a damp atmosphere in the laboratory. It was stated by the firm, however, that the optical perfection of figure was in some degree spoilt, but that it remained good enough, for example, for prisms used in infra-red spectroscopy.

The above information has been verified by simple experiments carried out here. These experiments indicate a substantial improvement in resistance to atmospheric corrosion. No attempt has been made to work out in detail the best conditions of heat treatment to get a suitable compromise between resistance and loss of figure, but the method is believed to be valuable. Attention is directed to the phenomenon in case it should be thought worthy of further investigation.

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Determination of the Frequency of Flexural Vibrations of Reeds by a Lissajous Figures Method

IN a recent paper[1], I described a method for determining the frequency of lateral vibrations of thin rods by measuring the time for one quarter of an oscillation. The application of the method is limited to hard metals. A more simple, more accurate and more general method of measuring the frequency of transverse vibrations of any material obtainable in the form of a wire or a thin strip can now be described.

A short filament of the material is clamped horizontally from one end and placed close to a thick sonometer wire carrying at its mid-point a small lens facing the free end of the filament, which can vibrate in a plane at right angles to the plane of vibration of the lens. A bright point at the tip of the test material is viewed through the lens. The filament is excited by a gentle touch on the massive clamp, and at the same time the sonometer wire is excited by plucking. Lissajous' figures will be observed. The length and/or the tension of the sonometer wire is adjusted until a practically stationary pattern is seen, from which the frequency ratio is determined. If the figure is a loop (which must not be confused with the loop traced by the free end of a vibrating wire having a circular cross-section), the ratio is 1 : 1. The frequency of the sonometer wire is then measured in the usual acoustical way with the aid of an auxiliary wire and a known tuning fork. An accuracy of 1 per cent can be easily obtained.

As the frequency of the adjustable vibrator approaches the natural frequency of the filament, the latter may be thrown into resonant vibrations if the damping is small, and at this stage independent excitation of the filament is usually unnecessary. At exact resonance, the Lissajous' pattern is most stationary. From a knowledge of the frequency, the density and the dimensions, Young's modulus can be evaluated for a length of about 1 cm. of a glass fibre or a phosphor-bronze suspension strip.

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[1] *Proc. Phys. Soc.*, **57**, 412 (1945).

Soap Bubbles in Reverse

WHEN sulphuric acid sodium sulphate solution containing surface-active material is dropped into water, bubbles approximately 5 mm. in diameter sinking through water may be observed. Such bubbles are spherical shells of air, with a sphere of acid sodium sulphate within and water outside. They are, in fact, soap bubbles in reverse. Instead of a two-surfaced film of soapy solution in air, these have a two-surfaced film of air in soapy solution. Moreover, like the ordinary soap bubble, they show interference colours.

In a typical case, the bubble forms, but may or may not sink; it depends on the density of the entering liquid, which has to be sufficient to overcome the buoyancy of the air shell, if the bubble is to sink. If the density is sufficient and the bubble sinks, it can be seen to burst on reaching the bottom. When this happens, there is a swirl of liquid as the two dissimilar liquids mix, and a tiny true bubble, a mere fraction of the original size, shoots up to the surface.

The conditions which allow these bubbles to form are those which cause sessile droplet formation[1]. It is believed that these reversed soap bubbles are sessile droplets which have penetrated the surface film, so that air closes around the drop. If this be true, it may be possible to calculate the dimensions of the air film between a sessile droplet and the under-layer, either by measuring rates of fall of these special bubbles, or by measurements involving the bubble colours.

The following conditions are suitable: a solution of 10 per cent sulphuric acid, 20 per cent sodium sulphate, 0·50 per cent cetyl pyridinium bromide. This is dropped from a height of 18 in. into water, in the form of coarse drops. At first few bubbles form, which may mean that it is necessary to have surface active material in both liquids. After a time they become fairly frequent. The largest bubble I have observed has been 10 mm., but most are 1–5 mm.

Other surface active materials may be used as well. In addition to the one given, which is a cation-surface-active substance, isopropyl naphthalene sulphonic acid (anionic), and cetyl polyglycol ether (non-ionogenic), have been used with success.

I believe that this phenomenon is more widespread than might be thought. The accident of using a high-density solution, causing the bubbles to sink, directed my attention to them. Since then, I have seen bubbles in different circumstances which appear to rise more slowly than their size warrants. Perhaps the 'soap bubble in reverse' is as common as its more obvious congener.

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[1] Benedicks and Sederholm, *Nature*, **153**, 80 (1944).

Interpolation Schedule for the Lagrange Formula

THE Lagrange interpolation formula is particularly valuable when it is desired to interpolate (or extrapolate to a moderate extent) into a series in which the independent variable moves in unequal steps. The formula takes the form

$$Y = \frac{(X-x_2)(X-x_3)\ \ldots\ (X-x_n)}{(x_1-x_2)(x_1-x_3)\ \ldots\ (x_1-x_n)}\,y_1 + \frac{(X-x_1)(X-x_3)\ \ldots\ (X-x_n)}{(x_2-x_1)(x_2-x_3)\ \ldots\ (x_2-x_n)}\,y_2 + \ldots$$

where y takes on values $y_1, y_2, y_3 \ldots y_n$ for values of x of $x_1, x_2, x_3 \ldots x_n$ and the value of $y = Y$ for $x = X$ is desired to be interpolated.

This formula is rather formidable, the main difficulty being in computing the coefficients of $y_1, y_2 \ldots y_n$, in that, when handling the large number of subtractions involved, it is particularly easy to introduce errors.

An interpolation schedule described by Dale S. Davis[1] goes a long way towards systematizing the operations involved, but still leaves room for error, since the numerator and denominator units of the coefficients are computed from separate tables, the coefficient formed and finally multiplied by the appropriate value of y. There is thus some risk of incorrectly selecting the numerator, denominator and y-values. A slight modification of the Davis schedule has been devised which may be of value to those employing this interpolation formula and is particularly suitable for use with a slide rule.

Let y take on the values y_1, y_2, y_3 and y_4 for values of x of x_1, x_2, x_3 and x_4. It is desired to find the value of $y = Y$ when $x = X$. A table is drawn up as shown herewith.

y	x	x_1	x_2	x_3	x_4	+	−
y_1	x_1		$X-x_2$ / x_1-x_2	$X-x_3$ / x_1-x_3	$X-x_4$ / x_1-x_4		
y_2	x_2	$X-x_1$ / x_2-x_1		$X-x_3$ / x_2-x_3	$X-x_4$ / x_2-x_4		
y_3	x_3	$X-x_1$ / x_3-x_1	$X-x_2$ / x_3-x_2		$X-x_4$ / x_3-x_4		
y_4	x_4	$X-x_1$ / x_4-x_1	$X-x_2$ / x_4-x_2	$X-x_3$ / x_4-x_3			

First come two columns representing the values of y and x respectively. Then come four columns headed by the values of x respectively. Finally come two columns headed by the signs '+' and '−' respectively. The 16 cells formed by the values x_1, x_2, x_3 and x_4 occurring as columns and rows are divided diagonally from left up to right, and the single main diagonal from left down to right is also inserted. The method of filling in each half-cell will be clear from the table—in the upper half of each cell is placed the difference between X and the values of x occurring as column headings, while the lower halves contain the difference between the values of x occurring as row headings and the value of x occurring as column headings. Cells containing both diagonals are left blank. The slide rule is now set at the value y_1, multiplied by $X-x_2$, divided by x_1-x_2 (first cell in the y_1 row), multiplied by $X-x_3$, divided by x_1-x_3 (second

cell in the y_1 row), and so on across the y_1 row. When computing on a slide rule, this operation involves, of course, alternate movements of cursor and slide. The result is placed in the '+' or '−' column according as the row contains an even or an odd number of *minus* signs. This operation is performed for each row until the '+' and '−' columns have been filled. The '−' column is summed and subtracted from the total of the '+' column to give the required value of $y = Y$. The table is not, of course, confined to four pairs of values, but may be extended in an obvious manner.

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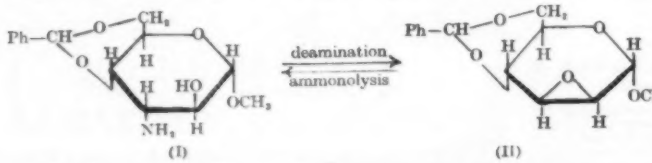
[1] Davis, D. S., "Empirical Equations and Nomography" (McGraw-Hill Book Co., 1943), p. 61.

Reversible Conversion of Amino- into Anhydro-sugars

Anhydro-sugars have already been the subject of diligent study by several groups of workers, and the chief methods of obtaining these compounds have been through the hydrolysis of sulphonic or halogen acid esters of sugar derivatives. For example, 2 : 3-anhydro β-methyltaloside was obtained by alkaline hydrolysis of 2-*p*-toluene sulphonyl β-methylgalactoside[1]; 1 : 6-2 : 3-dianhydro β-talose was isolated after the alkaline hydrolysis of 2-mesyl 1 : 6-anhydro β galactose[2], and 3 : 6-anhydro β-methylglucoside has been obtained by the hydrolysis of 6-bromo β-methylglucoside[3]. Sulphuric acid esters of sugars have also been made to yield anhydro-derivatives. For example, Duff and Percival[4] obtained 3 : 6-anhydro β-methyl glucopyranoside from barium β-methyl glucopyranoside sulphate. Finally, the same type of reaction has been applied to the nitric acid esters of sugars. Gladding and Purves[5] obtained a product which probably contained 2 : 3-anhydro β-methyl-mannoside from 3 : 4 : 6-triacetyl β-methylglucoside 2-nitrate and 3 : 6-anhydro α-methyl-glucoside from 2 : 3 : 4-triacetyl α-methylglucoside 6-nitrate.

Now it has been found that methyl glycosidic derivatives of amino-sugars can very easily be converted into anhydro-sugars of the ethylene oxide type by removal of the amino-group with nitrous acid. Thus, deamination of 2-amino 4 : 6-benzylidene α-methylaltroside results in a quantitative yield of 2 : 3-anhydro 4 : 6-benzylidene α-methylalloside, and deamination of 3-amino 4 : 6-benzylidene α-methylaltroside (I) gives 2 : 3-anhydro 4 : 6-benzylidene α-methyl-mannoside (II). Deamination has, as would be expected, been accompanied by Walden inversion at the carbon atom originally carrying the amino-group. Of course, it is well known that deamination of glucosamine yields an anhydro-sugar, chitose, but this change is not reversible. On the other hand, the change described here is a reversible one, for ammonia will reconvert the ethylene-oxide anhydro-sugar largely into the original amino-sugar derivative.



(I) (II)

The deamination of similar derivatives of the naturally occurring amino-sugars, glucosamine and chondrosamine, is being investigated.

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Oct. 18.

[1] Wiggins, *J. Chem. Soc.*, 522 (1944).
[2] James, Smith, Stacey and Wiggins, *Nature*, **156**, 308 (1945).
[3] Fischer and Zach, *Ber.*, **45**, 456 (1912).
[4] Duff and Percival, *J. Chem. Soc.*, 830 (1941).
[5] Gladding and Purves, *J. Amer. Chem. Soc.*, **66**, 76 (1944).

A New Crystalline Plant Virus

Among several viruses attacking cruciferous plants is one which affects turnips and, so far as we know, has not been previously described. The main symptom produced on the turnip is a bright yellow and green mosaic mottling, and the name we suggest for the virus is 'turnip yellow mosaic virus'. The host range is rather limited, but Chinese cabbage, *Brassica chinensis*, var. Chihli, is susceptible and reacts to infection with a brilliant white, yellow or green mottling which resembles a variegation rather than a mosaic (Fig. 1).

During studies on this virus we found that, unlike the other viruses attacking Cruciferæ, it was in high concentration in the plant and was infectious at dilutions of 1×10^{-6}. Like most plant viruses which occur in high concentration in their hosts, this virus is apparently not insect-transmitted, although we have some evidence that it may be seed-borne in about 2–3 per cent.

For making the virus preparation, the Chinese cabbage was used and the procedure is as follows. Leaves showing systemic infection are minced unfrozen and the sap is expressed. This is then centrifuged to remove coarse particles, and one third the volume of 97 per cent ethyl alcohol is added. The coarse coagulum which forms contains the virus, and after standing for some hours this is spun down. The clear yellow supernatant liquid is discarded. The green sediment which contains the virus is extracted with 0·5 per cent sodium chloride solution, the volume used being about a third to a half that of the original sap. The suspension is then centrifuged to remove the insoluble plant material. On the addition of ammonium sulphate to one third saturation to the supernatant liquid, the virus is deposited as small crystals.

Fig. 1. Leaf of Chinese cabbage showing the marked mosaic mottling caused by turnip yellow mosaic virus.

After standing for a time to allow full precipitation of the virus, the crystals are centrifuged off at slow speed. They are re-dissolved in a small volume of water and the solution is centrifuged to remove insoluble material. The virus is then re-deposited as crystals by the addition of half a volume of saturated ammonium sulphate solution. The yield is approximately 170 mgm. from 1 litre of sap, and the isolation procedure is unquestionably more simple than that of any other virus, not excluding tobacco mosaic virus.

The crystals of turnip yellow mosaic virus (Fig. 2) are very small, are isotropic and appear to be octahedral. They dissolve readily in water to give a colourless, opalescent solution. As in the case of the viruses of tomato bushy stunt and tobacco necrosis, the turbidity which develops on the cautious addition of ammonium sulphate to solutions of the virus at room temperature is reversed on cooling; but turnip yellow mosaic virus differs from the former viruses in that it crystallizes so readily from ammonium sulphate solutions that, after a few minutes at room temperature, crystallization has begun and the turbidity is then not removed by cooling.

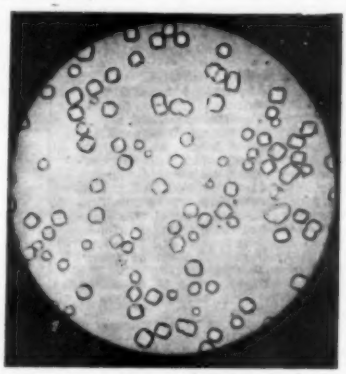

Fig. 2. Crystals of turnip yellow mosaic virus (1/12th oil immersion lens).

Solutions of the virus give biuret and Molisch reactions, and the ultra-violet light absorption shows the maximum at about 260 mμ, which is given by nucleic acid and nucleoproteins.

The phosphorus and carbohydrate content are those of a nucleoprotein containing about 16 per cent of nucleic acid of the ribose type.

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A Method of Testing the Antimalarial Properties of Compounds *in vitro*

THE rate of haemolysis produced *in vitro* by the haemolytic substance isolated from normal blood plasma[1] has been found to be decreased on addition of antimalarial drugs in low concentration (1 : 5,000 to 1 : 40,000). Closely related inactive compounds did not affect the rate of haemolysis. Quinine, 1 : 10,000, for example, delayed the lysis time from one minute in the control to between 20 and 30 minutes, while a number of inactive quinoline, quinaldine and quinidine compounds failed to affect the rate of lysis.

Altogether, 117 substances, comprising active and inactive compounds, have been examined by the lysis test, as shown in the accompanying table :

	Known antimalarial activity	No. of drugs	Result of lysis test	
			Haemolysis delayed (= active)	Haemolysis not affected) (= inactive
I	active	39	38	1
II	slightly active	7	5	2
III	apparently inactive	17	5	12
IV	inactive	54	4	50

In Group I, 38 out of 39 antimalarial compounds were found to be active by the lysis test. Groups II to IV showed a certain discrepancy between antimalarial activity and lysis test : two slightly active drugs did not inhibit the rate of lysis, while a few of the apparently inactive drugs were found to do so. These differences may be due to the following facts : (1) the conditions of the lysis test as applied in these experiments (horse erythrocytes in isotonic phosphate buffer solution, pH 7·3) may as yet be far from optimal ; (2) some antimalarial drugs reveal their activity in one host only, as for example in ducks, and are inactive in chicken, canary, monkey and man. Their antimalarial action, therefore, may not have been revealed by the particular biological test used for determining their activity.

Several other haemolytic substances such as cobra lysoiecithin, saponin, sodium dodecylsulphate, sodium desoxycholate, ethylene glycol, ammonium acetate and ammonium oxalate have been substituted for the naturally occurring haemolytic substance in tests with quinine, mepacrine, paludrine, and a few other active and inactive compounds. The results of these tests were, however, entirely inconclusive, none of the haemolytic substances giving any useful indication which would help to distinguish between the antimalarial activity or inactivity of compounds.

The marked parallelism between the antimalarial properties of compounds and their inhibitory effect on the haemolysis *in vitro* produced by the naturally occurring haemolytic substance makes possible the introduction of an additional test for screening potential antimalarial compounds. This parallelism makes it conceivable that the malaria parasites at some stage of their development produce a metabolite closely related to the naturally occurring haemolytic substance, and that the effect of antimalarial drugs *in vivo* is bound up with their action on this metabolite. The results of this work, summarized above, constitute a step towards the biochemical approach to the study of the chemotherapy of malaria.

My thanks are due to Prof. D. Keilin for his interest in this work and for much stimulating and critical advice ; also to Dr. H. King of the National Institute for Medical Research, London, and to Dr. F. H. S. Curd and Dr. D. G. Davey of the Biological Department of Imperial Chemical Industries, Ltd., who have kindly supplied me with several series of drugs.

A detailed report will appear elsewhere.

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Dec. 12.

[1] Laser, H., and Friedmann, E., *Nature*, **156**, 507 (1945).

Penetration of Water into Erythrocytes with Heavy Water as Indicator

THE usual methods of studying the water metabolism of the red corpuscles always change the salt concentration of the surrounding medium. It has not yet been possible to follow the passage of water in and out under normal isotonic conditions. This can be done now by using heavy water.

Blood samples are collected from normal adults or patients with pernicious anæmia : to prevent clotting, sodium citrate or heparin is added. 0·1-0·3 c.c. of a 7·9 per cent deuterium solution in distilled water or 9 parts per thousand sodium chloride are added to about 5 c.c. blood. After a time ranging from 1 minute to 45 minutes, the blood is centrifuged and a small volume of both plasma and packed red cells is drawn. In one experiment the plasma was made hypotonic before the addition of heavy water.

The amount of deuterium is estimated by measuring the density of the water according to the method of Linderstrøm-Lang[1] : density is given in 'units', that is, the difference, multiplied by 10^6, between the density of the sample and that of pure water at the same temperature. The water of the samples is completely distilled off in vacuum, the samples being maintained at room temperature while the water is trapped in liquid air. The water is purified as described by Ussing and Wernstedt[2].

Even after a very short time, the water of the red corpuscles and that of the plasma have the same density. Water enters the erythrocytes so quickly, both under normal conditions and in a hypotonic medium, that the existence of a *continuous* exchange of water between plasma and red corpuscles must occur. Wolpers[3] and Ruska[4], using the electron microscope, have recently shown that the surface layer of the red corpuscles has a proteic framework, filled up by lipoid material.

Temp. (° C.)	Time of contact	Density		Anti-clotting	Observations
		Plasma	Erythrocytes		
24°	—	188	188	citrate	normal
24°	6	136	136	heparin	pernicious anæmia
24°	4	129	117	citrate	normal
24°	3	440	407	,,	,,
24°	3	471	528	,,	,,
6°	1	153	153	,,	,,
6°	21	148	153	,,	,,
6°	3	136	136	,,	,,
6°	1	191	181	heparin	pernicious anæmia
24°	3	353	353	citrate	normal
24°	3	400	384	,,	,,
24°	45	295	303	,,	,,
24°	45	610	610	,,	blood diluted with water (1 vol. water + 1 vol. blood)

Our experiments establishing the identity of the water inside and outside the erythrocyte suggest that its surface, although it shows a frame-like structure[3], must have a large number of very small fissures or holes, through which water passes in and out.

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[1] Linderstrøm-Lang, Jacobsen, O., and Johansen, G., *C.R. Lab. Carlsberg*, **23**, 17 (1938).
[2] Ussing, H., and Wernstedt, A., *Skand. Arch. Physiol.*, **83**, 169 (1940).
[3] Wolpers, C., *Naturwiss.*, **29**, 416 (1941).
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Quantitative Assay of Aneurin (Vitamin B_1)

IN the course of an investigation of base-exchange of aneurin (vitamin B_1) on zeolitic materials, it has been found that sands display properties which suggest that they possess a zeolitic surface layer. Using this property for a process of purification, a quantitative method has been developed for the estimation of vitamin B_1 in wheat products.

As might be expected, it has been found that wheat ground with sand and water gives a lower aneurin assay than wheat ground in a laboratory grinder. The importance of this in the grinding of biological material for the subsequent recovery of basic substances is obvious.

Full details of the work done are being published.

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Effect of Antiseptics on the Germination of Pollen Grains

POLLEN grains from many plants can be readily germinated on 30 per cent solutions of cane sugar with 0·8 per cent of gelatine. The rate of germination varies ; but in many Labiates it begins within fifteen minutes at room temperature, and growth is obvious under a 2/3 objective with a micrometer eyepiece.

It has been found that many substances with bacteriostatic properties inhibit the formation of pollen tubes, in concentrations similar to bacteriostatic values. For example, phenol inhibits germination at 0·0035 per cent, and formalin at 0·01 per cent with white dead nettle pollen ; and these values are similar to those found from many other pollens. Merthiolate is effective at 0·0002 per cent.

Pollen grains germinate, however, in very high concentrations of penicillin. The effective concentration varies slightly from plant to plant ; with white dead nettle no inhibition is found at 5,000 units per c.c. ; Eschscholtzia pollen is inhibited by 250 units per c.c.

In general, then, pollen grains show the same order of sensitivity to antiseptics as bacteria ; but their sensitivity to penicillin is negligible, and of the same order as vertebrate cells in tissue culture.

The germination of pollen grains in the Labiates does not involve cellular multiplication. Presumably the development of the pollen tube is due to endosmosis, with distension of an elastic membrane, which becomes immediately inelastic except at the tip. This view is supported by the fact that if the temperature be raised the pollen-tube ruptures at the tip ; the same effect follows the lowering of sugar concentrations.

The remarkable rate at which tube development takes place makes pollen grains very suitable objects for biological test. In many species, for example, iris, there is a striking movement of granules in the tubes ; this movement may be studied in relation to antiseptic concentrations.

How antiseptics control pollen germination is not known ; one reason may be an effect on the elastic membrane of the grain ; another an effect on the contents of the grain which determine osmosis. Whatever the cause, penicillin is distinguished from other bacteriostatic agents by its inefficiency.

Technique. A solution of 60 per cent cane sugar and 1·6 per cent gelatine is sterilized by autoclaving. One platinum loopful of this solution is mixed on a cover-slip with a loopful of the antiseptic to be tested. Ripe stamens of the flower selected are stroked with a sterile needle, held just over the cover-slips; a control of 30 per cent cane sugar is set up from the same flower.

Strips of adhesive plaster are applied on either side of the depression in a hollow-ground slide. The surface of the plaster is smeared with 'Vaseline' and a 'hanging drop' preparation made. The slides are placed in moist chambers, prepared by placing moistened filter paper disks in petri dishes; they are examined with 2/3 objective and × 8 ocular with micrometer scale after fifteen minutes at room temperature.

Liberal sowing is desirable, as a number of grains do not germinate in controls. White dead nettle is a convenient pollen, as this plant flowers all the year round, and is very common; the grains germinate in fifteen minutes. However, it shows no protoplasmic streaming.

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Chemical Production of Mutations

In a previous letter in *Nature*[1], chemical substances were mentioned which are as effective as X-rays in inducing mutations and chromosome rearrangements. The chemical nature of the main substance used can now be stated. It is dichloro-diethyl-sulphide, or mustard gas. Three other substances of similar efficiency were found, all of them chemically related to mustard gas. Lewisite, on the other hand, gave negative results. The results were first described in a report sent to the Ministry of Supply on March 14, 1942.

In a large-scale test on the production of mutations by mustard gas carried out in April 1941, *Drosophila melanogaster* males were exposed to volatilized mustard gas and afterwards tested for sex-linked lethals by the standard CIB method. 7·3 per cent lethals were obtained in more than 1,000 chromosomes, as compared with 0·2 per cent in the controls. In later tests, even higher mutation-rates (up to about 24 per cent) were obtained. The limit for the increase in mutation-rate by increase of dosage is given by the equally increased rate of dominant lethality in the F_1: doses which produce more than 20 per cent sex-linked lethals practically sterilize all the treated males.

The mutagenic action of mustard gas appears to be exercised directly on the chromosomes, and not by way of a change occurring primarily in the cytoplasm; for the mutation-rate is not increased in untreated spermatozoa which have been introduced into treated eggs. Various rearrangements (inversions, large deletions, translocations) have been produced by the treatment. But the frequency of translocations is lower than would be expected after a dose of X-radiation which produces the same percentage of sex-linked lethals; it is, however, still considerably higher than after ultra-violet treatment. Thus, in one experiment with mustard gas in which the frequency of sex-linked lethals was 8·6 per cent, only seven translocations involving the *X*-chromosome and/or the two large autosomes were found in 812 treated chromosome sets.

The visible mutations which have so far been produced by chemical treatment have, with one exception, been previously described. In the progeny of chemically treated males, 30–50 per cent of visible mutations occur as 'fractionals', a proportion which is considerably higher than that observed in progenies of X-rayed males.

Full details of these results will be published elsewhere.

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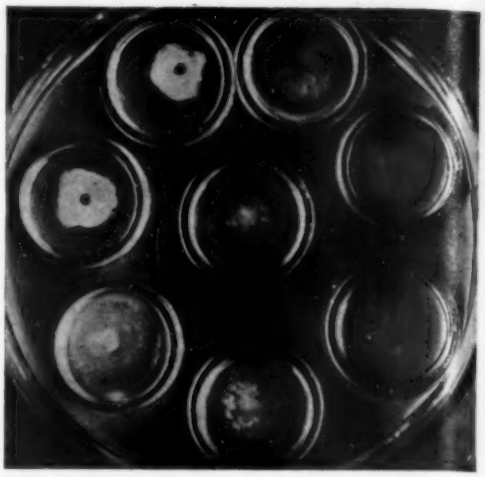
[1] Auerbach and Robson, *Nature*, **154**, 81 (1944).

Silica Jelly as a Substrate for Counting Holozoic Protozoa

THE study of selective feeding[1–5] of soil protozoa, especially amœbæ, on a large number of bacterial strains, led to the development of an improved method[6] of counting soil Protozoa. In the past, dilution methods[7] of estimating Protozoa numbers have suffered, first from having too few replicates, and secondly from the use of unspecified bacterial food. These two difficulties have been met in the method described, the first by making a number of separate cultures enclosed by glass rings in each petri dish, and the second by using, as food supply, pure cultures of bacteria known to be edible to Protozoa. These food bacteria have in the past[4] been spread on the surface of washed agar made up with 0·5 per cent sodium chloride. It has been found, however, that silica jelly may be more advantageously used for two main reasons. First, it further reduces the growth of organisms coming in with the inoculum; and secondly, it has another advantage over agar because it does not allow the growth of agar-liquefying organisms which may be abundantly present in certain substrates.

Silica jelly is easy to make, and can be sterilized for the purpose of counting Protozoa. A 10 per cent solution from liquid sodium silicate (B.D.H.) is made in distilled water. The sodium silicate quickly dissolves in water by gently warming it. 4 c.c. of 2*N* hydrochloric acid is poured into a petri-dish and 2 3 drops of brom-thymol blue are added. Now a 10 per cent solution of sodium silicate is slowly added to the hydrochloric acid and the petri dish is gently rotated to mix the sodium silicate until a grass-green colour is obtained. About 15–20 c.c. of 10 per cent sodium silicate is required and the pH of the medium should then be about 6·8–7·0. Eight glass rings are quickly put in the silica jelly before it solidifies; the rings are firmly embedded in the jelly when it has set. With a little practice it takes about two minutes to make a plate. The plates are then put, with the lids removed, in a tank under running water for 24 hours or longer to get rid of most of the salt. Then they are immersed for 24 hours in



normal saline solution, which provides an osmotic pressure in the silica jelly suitable for Protozoa. The water is drained from the plates and they are sterilized with the lids on by dry heat in an oven at about 80°–100° C. for an hour or more. This temperature is sufficient to kill Protozoa, both active and cystic, if they happen to have fallen into the plates during the course of preparation. The plates are now ready for use. A strain of a pure culture of one or a mixture of several suitable bacteria (2–7 days old culture) is spread over the silica jelly contained in the glass rings, in the form of a thick disk or 'bacterial circle'. In the count of soil Protozoa fifteen two-fold dilutions are made ranging from 1/5 to 1/81,920, with eight replicates at each level and with an inoculum of 0·05 c.c. added at the centre of the 'bacterial circle'. The number of Protozoa per gram of soil is then estimated from the count of negative cultures (that is, showing no Protozoa) by applying the method of Fisher and Yates[8], Table VIII, 2. The accompanying photograph shows two negative and six positive cultures.

A few counts that have been made on silica jelly from a decomposing compost heap of straw and sludge set up at Rothamsted farm are given in the accompanying table.

Date	Samples	Total amœbæ per gm.	Cystic amœbæ per gm.	Active amœbæ per gm.
April 16, 1945	*A*, taken from 3 in. depth	467,000	70,500	396,500
	B, taken from 6 in. depth	211,000	17,300	193,700
April 21, 1945	*A*, taken from 2 in. depth	256,000	—	—
	B, taken from 4 in. depth	121,000	—	—

It seems that the number of amœbæ decreases as the samples are taken from a greater depth. This is probably due to either an increase in temperature or the lack of oxygen or both.

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Oct. 3.

[1] Singh, B. N., *Ann. Appl. Biol.*, **28**, 52 (1941).
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Nature of the Cyst Wall of the Potato-Root Eelworm *Heterodera rostochiensis*, Wollenweber, and its Permeability to Water

EELWORM cysts are white and soft when first formed on the roots of potato plants: afterwards they turn yellow and eventually become brown and hard. I have been able to demonstrate that this process is due to the activity of polyphenol oxidase*; white cysts will oxidize catechol and tyrosine, and the action of the enzyme can be inhibited by carbon monoxide, hydrogen sulphide, potassium cyanide, potassium ethyl xanthate, and sodium diethyl carbamate, substances known to

* With material kindly supplied by Mr. F. G. W. Jones, School of Agriculture, Cambridge, I have since been able to show that this enzyme is also present in the beet eelworm, *H. schachtii* Schm.

inhibit polyphenol oxidase[1,2]; the last two reagents react specifically with the copper in the enzyme, and it was possible partially to reverse their inhibiting action, as recently described for the enzyme from mushrooms[3], by the addition of cupric chloride. Moreover, the cysts can be induced, by the addition of benzoquinone, to turn brown in the presence of an inhibiting substance such as carbon monoxide; and the presence of polyphenols can be detected in the cyst wall with Tollen's solution (ammoniacal silver hydroxide). The process of hardening of the cyst wall, then, is fundamentally the same as that by which insect cuticle is hardened[2]. It has recently been demonstrated[4,5] that insect cuticle owes its impermeability to water to an outer layer of a waxy substance and not to the nature of the bulk of the cuticle itself. I have been unable to detect such a layer on the eelworm cyst, and, as would be expected, therefore, the cyst wall is permeable to water.

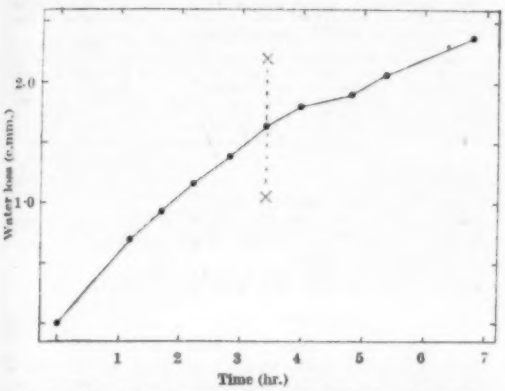

Fig. 1. WATER-LOSS THROUGH THE CYST WALL OF THE POTATO-ROOT EELWORM. AT THE POINT *X*, PART OF THE CYST WAS COATED WITH RUBBER SOLUTION, THUS REDUCING THE RATE OF WATER-LOSS.

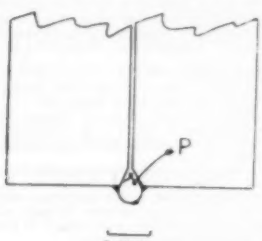

Fig. 2. AN EELWORM CYST IS SEALED ON TO THE END OF A FINE-BORE CAPILLARY TUBE FILLED WITH WATER SO THAT ITS 'STALK' LIES IN A SMALL CUP. THE RUBBER SEAL OVER THE VULVA OF THE CYST AND FROM THE CYST TO THE TUBE IS SHOWN IN BLACK. IN CERTAIN PREPARATIONS, THE CYST IS PUNCTURED AT A POINT *P* BEFORE IT IS SEALED ON TO THE TUBE; THIS RESULTS IN AN INCREASED RATE OF WATER-LOSS.

The potato-eelworm cyst has two openings, corresponding to the mouth and vulva of the mature female; the former lies at the tip of the cyst 'stalk'. The vulva is first sealed with rubber solution; a fine glass capillary tube, already filled with water, is then slipped over the 'stalk' and sealed on to the cyst. Clearly, if the cyst wall is permeable to water, water will pass into the cyst *via* the opening at the end of the 'stalk' to replace that which is lost by evaporation through the cyst wall; this, in fact, is the case, and the movement of the fluid in the capillary can easily be followed with an eyepiece micrometer. The results of a typical experiment are shown in Fig. 1: at the point *X*, part of the cyst was coated with rubber solution; an immediate fall in the rate of movement resulted. A large cyst has a diameter of about 0·6 mm. and a volume of about 0·11 c.mm.: this volume of water will be lost in 10–15 min.

A more robust and useful preparation can be made with very fine bore thick-walled capillary tubing; broken thermometers serve very well. A very small bulb is blown at one end: this end is then ground down to give a small cup at the end of the fine capillary. The tube can be mounted vertically, cup uppermost, under a dissecting microscope; the end of the tube then provides a small dissecting platform on which a cyst, with vulva already sealed, can be manipulated so that the 'stalk' enters the cup. The cyst is then sealed to the tube, as shown in Fig. 2, an effective seal being easily obtained.

The rate of movement usually falls off with time; this is almost certainly due to a decrease in permeability. Water apparently does not enter the cyst rapidly enough, and the cyst wall tends to dry out and is noticeably harder at the end of an experiment. This, in turn, reduces the rate of water loss. Apparently, the rate of entry of water through the minute opening at the end of the stalk constitutes a limiting factor; if a small puncture is made at a point *P* in Fig. 2 before it is sealed on to the tube, the rate of water loss is very much greater than in normal preparations and the cyst wall stays softer and more flexible. In Nature, an exposed cyst might reduce the rate at which it loses water by the drying out and consequent hardening and contracting of the cyst wall.

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Oct. 29.

[1] Keilin, D., and Mann, T., *Proc. Roy. Soc.*, B, **129**, 1 (1940).
[2] Tenenbaum, L. E., and Jensen, H., *J. Biol. Chem.*, **147**, 27 (1943).
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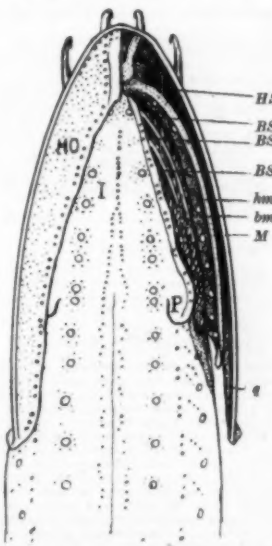
The Ventral Part of the Hyoid Gill-Slit and a Mandibular 'Operculum' in some Bony Fishes

(1) *The hyoid gill-slit.* It is commonly accepted that in all living fishes there is no sign of a ventral part of the hyoid (facial) gill slit, that the latter has vanished entirely, and that all that is left of it is a small relic of its dorsal extremity which survives as a spiracle in some primitive forms. Nevertheless, all fishes of the family Malacosteidæ (Stomiatoidea) have a large, wide open slit between the mandible and the ventral part of the hyoid arch, that is, corresponding exactly to the ventral part of the hyoid (facial) gill-slit. The fact itself was known long ago, but was described in somewhat obscure terms, and its significance was overlooked.

Describing this structure in *Malacosteus*, Günther (1887, p. 215) emphasizes that "it is a perfectly unique structure", and says that it consists of "a thin cylindrical muscular band which connects the back part of the mandibulary symphysis with the extremity of the hyoid bone". Günther saw the unusually exposed muscles, but did not notice the slits. Zügmayer (1913, pp. 1–2) described the hyoid slits in Malacosteidæ as the absence of the floor of the mouth ("plancher de la bouche"), which certainly is not exact. Zügmayer's terminology was adopted by later writers, and though Regan and Trewavas (1930, p. 133) noted that in Malacosteidæ "there is no membrane between the lower jaw and the hyoid arch", the unique fact of the presence of the ventral part of the hyoid gill-slit escaped the notice of morphologists.

In Malacosteidæ the hyoid bar has no gill, and it seems likely that the slit has been secondarily re-acquired. This may have happened thus. In many teleostean fishes with large jaws and with a highly movable ventral part of the hyoid and branchial arches (pike, hake, turbot, etc.), the wall of the pharyngobranchial cavity between the mandible and the hyoid arch is thin and extensible. In some Stomiatoids (which have much larger jaws than most fishes) the extensibility of this wall and of the muscles between the hyoid bars and



VENTRAL VIEW (DIAGRAMMATIC) OF THE HEAD OF A MALACOSTEID (*Photostomias guernei* COLLET). THE LEFT MANDIBULAR FOLD REMOVED. THE GILL-SLITS ARE SHOWN BLACK. CIRCLES AND DOTS OF DIFFERENT SIZE ON THE BODY AND ON THE MANDIBULAR FOLD REPRESENT THE LIGHT ORGANS.

bm: branchiostegal membrane; BS_1, BS_2, BS_3: first, second and third gill-slits; *hm*: hyoid muscle; *HS*: hyoid gill-slit; *I*: 'isthmus'; *M*: mandible; *MO*: mandibular 'Operculum'; *P*: rudimentary pectoral fin with a fold extending forwards; *q*: inner side of the quadrate. The fourth and fifth gill-slits are not visible.

the tip of the mandible is extreme, and when the mouth is opened and this wall is extended, the latter appears as a very thin and transparent membrane. When the mouth is shut, this wall is folded up like a curtain hidden between the mandible and the hyoid-bar. In Malacosteidæ, the mandible is even larger than in other Stomiatoids, the extensibility of the hyoid muscles still greater, and it seems possible that the part of the wall of the branchio-oral cavity between the rami of the mandible and the hyoid bars was perforated; and that thus a hyoid slit secondarily reappeared.

This is a suggestion only, and is not based on a study of the embryonic development of this slit, which has never been investigated in these fishes.

(2) *The mandibular operculum.* In Malacosteidæ the mandible extends backwards much farther than usual in fishes, so that a large part of the belly, the chest with the pectoral fins, and the heart, are situated between the rami of the mandible. On the other hand, the 'isthmus' and the ventral parts of the hyoid and branchial arches extend much anteriorly and almost reach the symphysis of the mandible, while the dorsal parts of the branchial arches are short. Thus the branchial chambers have an unusually large ventral and anterior extension, and their greater part is situated between the anterior portion of the rami of the mandible. Consequently, the hyomandibular opercles are much reduced and their bony support is very weak; but on the ventral side, between the rami of the mandible, another opercular cover has appeared. This cover consists on each side of a fold along the ventral edge of the mandible extending backwards to the mandibulo-quadrate articulation, then turning round this articulation and passing upwards along the posterior edge of the quadrate to the point where the interhyal is attached to the suspensorium. This fold covers ventrally the space between the mandible and the isthmus. On the lateral side of the isthmus there is another fold extending from the pectoral fin to the anterior end of the isthmus. These two folds facing each other completely shut from beneath the ventral part of the branchial chamber.

The branchiostegal membrane in Malacosteidæ is low and completely enclosed in the ventral part of the branchial chamber (when the rami of the mandible are not separated). The current of water entering through the hyoid slit reaches the gills freely; and thus this slit in Malacosteidæ not only corresponds structurally to a hyoid gill-slit, but to a great extent probably also functions as a gill-slit.

The folds along the edges of the mandible and the quadrate correspond to a mandibular operculum. It is not supported by bones.

It seems of some interest that two such 'Acanthodian' characters are found in fishes which do not differ in other respects from the 'true' teleosts.

The problems mentioned here will be dealt with fully elsewhere.

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Hermaphroditism in a Terrestrial Isopod

IN July last Dr. H. W. Howard forwarded to me a specimen of *Armadillidium vulgare* (Latreille) in which he pointed out that the styles were very small. On examination, this was confirmed, and I also noted that the oostegites had commenced to form. The specimen was carefully watched for eleven weeks, when it died; no further development had taken place. On examining the specimen internally, I found that the two ovaries were present, but only about half the size of those normally present. The two oviducts were quite normal. Moreover, on the animal's right side there was a duct, which opened on to the first appendage of the metasome, but no trace of testes. The anterior portion of this duct was slightly wider (vesicular seminalis) than the longer posterior half (vas deferens). Legrand[1] has described a case in this same species.

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[1] *C.R. Acad. Sci.*, 808 (1941).

South African Onychophora

DR. S. M. MANTON has directed attention[1] to two papers on South African Onychophora by Holliday in the *Annals of the Natal Museum*[2,3], and to the absence of references to published literature therein.

Mr. Holliday is a civil engineer without specialized knowledge of biology, and at my suggestion kept a number of *Peripatus* in captivity for the purpose of making a permanent photographic record of various incidents in the life-history of the animals which, so far as I was aware, had never been previously photographed. At the beginning of the study, Mr. Holliday knew nothing of the habits of *Peripatus* or of previous work which had been done on these animals; various notes and observations during the year and a half in which *Peripatopsis moseleyi* and *Opisthopatus cinctipes* were kept in his laboratory were set down in his own words and at my request arranged for publication as an accompaniment to the photographs. While the illustrations of Holliday's paper undoubtedly represent a new contribution to our knowledge of *Peripatus* in so far as the activities which they portray, such as feeding, moulting, and the birth of the young, have not been previously photographed, no claim is made that the papers bring forward facts not hitherto known in the life-history of this animal. Their usefulness lies rather in the confirmation of many known facts by an independent observer free from the inevitable bias of previous knowledge, and in the support lent to these facts by photographic evidence.

As Dr. Manton says, the facts described have long been known; it is also true, however, that observations on the life-history of South African Onychophora are still scanty and many of them require further confirmation; a number of details still need to be filled in. The breeding period of *Peripatopsis moseleyi*, for example, is referred to very briefly by Manton in her papers[4]; the reference to it by Purcell[5] is more detailed but consists of only a single observation. During two successive years, females of *Peripatopsis moseleyi* kept by Holliday at Pietermaritzburg gave birth only in March and April, no young being born during the intervening period; his observations are thus at variance with those of Manton, whose females at Cambridge produced young from June to September, and agree with those of Purcell, both with regard to the time of the year and the average number of young born.

Steel's observations[6] show that in Australia the young of *Peripatus* (*Peripatoides*) *leuckarti* moult when between one and two weeks old; Holliday, on the other hand, found that the young of *Peripatopsis moseleyi* moulted a few minutes after birth.

Such discrepancies suggest that either the behaviour of *Peripatus* varies in different parts of the world, or that our knowledge of its life-history is as yet imperfect in many respects.

It is sincerely regretted if these two papers have given the impression that they claim to embody wholly new advances in our knowledge, or that they appear to ignore the work of previous authors, especially the outstanding contributions of Dr. Manton and her colleagues at Cambridge to the embryology, physiology and life-history of the South African Onychophora. The writer undertook his observations and contributed the notes as a lay observer, without knowledge of the more specialized investigations in the same field.

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[1] Manton, S. M., *Nature*, **156**, 338 (1945).
[2] Holliday, R. A., *Ann. Natal Mus.*, **10**, 237 (1942).
[3] Holliday, R. A., *Ann. Natal Mus.*, **10**, 433 (1944).
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[5] Purcell, W. F., *Ann. South Afr. Mus.*, **2**, 67 (1900).
[6] Steel, T., *Proc. Linn. Soc. N.S. Wales*, **21**, 94 (1896).

Gliding in Bats

WHILE watching a greater horseshoe bat flying up and down a hedge at dusk, I noticed that the bat glided for short intervals very frequently throughout its flight. This behaviour has been described by many writers.

Bats of this sub-order (Microchiroptera) do not maintain a constant body temperature, but, in the absence of muscular activity, take up a temperature approximately equal to that of their surroundings; they cannot fly unless their body temperature is above a certain minimum which is normally reached (for example, when waking up) by progressively increasing muscular activity, and maintained by the activity of flight.

It therefore seemed unlikely that the gliding periods in flight could be of very long duration, as they would cause the body temperature to fall below the critical minimum for flight. In addition, it seemed that they might be impossible at lower air temperatures (the original observations were made on a warm July evening), or for smaller animals in which the rate of cooling would be greater because of the relatively higher surface area.

Observations were therefore made on successive evenings, when the air temperature was recorded, and an attempt was made to measure the duration of the gliding period. The latter was only done roughly, by a counting method, but it was possible on each occasion to make forty to fifty observations, and they were found to give good consistency. The results obtained were as follows:

Air temperature	Mean duration of glide
64° F.	4/5–1 sec.
60° F.	1/5–2/5 sec.
51° F.	Bat did not glide.

Further observations were not possible, but the few that were taken suggest that there may be a relationship between temperature and gliding time.

The question of bat size was not examined, but it was noticed that even on the warmest evening the pipistrelle bats (a considerably smaller species), which were plentiful in the same place, showed no signs of gliding.

It would be interesting to know whether any similar observations have been made, and whether, if in fact there is a temperature factor involved in gliding, the larger bats would habitually glide for as long as possible. It may be a habit of one species only, or it may be that all bats would glide if it were warm enough.

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Some 'Water Divining' in Algeria

NEARLY three years ago, *Nature* printed an article entitled "Geology, Geologists, and the War Effort"[1], which included some animadversions upon dowsing.

The idea of dowsing fascinates many people, and it is not surprising to find that from time to time it forms the subject of sensational articles in the popular Press. Even serious claims for the possibilities of the practice do not err on the side of modesty, as may be appreciated from two letters recently published[2]. It is thus of importance to obtain objective data—hitherto scarce—as to the degree of precision attained by dowsers in their estimate of underground conditions at sites chosen by them for water wells.

In Algeria in 1943–44 I had opportunities of recording first some forecasts by three dowsers, two being French civilians (*A* and *B*), and one an enthusiastic British officer (*C*); and later the detailed

results obtained while sinking the wells on eighteen of their sites. Also the forecast by Dowser *B* of a site chosen by a geologist. The results are as follow:

Dowser *A* at Site 1 (Biskra)

	Forecast	*Fact*
Strata	0–36 m. (118 ft.) Impervious clays, etc.	0–58 ft., brown clay. –143 ft., gravels, with bands of gravelly clay.
Water	Between 31·25 m. and 34·88 m. (102·5 and 114·4 ft.)	At 80 ft.
Static level	2 m. (6·5 ft.) above surface	66 ft. below surface.
Yield	1,240 cub. m. (273,000 gallons) per hour (flowing)	2,500 gallons per hour (pumping).
Comment	Free flowing potable water rising through a fault	Hard, very saline water, potable only in emergency.

Dowser *B* at Site 2 (Beni Messous). Located by geologist

Forecast	*Fact*
No water would be obtained	Main water-level found at 235–240 ft. Static level 187 ft. below surface. Yield 850 gallons per hour, of very good quality potable water.

Dowser *B* at Site 3 (Beni Messous)

This was 300 yards distant from Site 2, and was located after that site had been successfully drilled; it was downhill from, and within 20 yards of, the uncased outfall of a hospital sewage disposal plant.

	Forecast	*Fact*
Strata	0–36 m. or 40 m. (118 or 131 ft.) gravel and loam, with traces of water –50 m. (164 ft.) sand and gravel, with water –53 m. (174 ft.) gravel with flowing water	0–212 ft. grey clay, stony 202–212 ft. –232 ft. pebbly sandstone. –236 ft. red clayey sand. –260 ft. ancient schists.
Water	See above	At 212 ft.
Static level	(Above ground-level)	113 ft. below surface.
Yield	Plenty of water; the intersection of two streams	500 gallons per hour, pumping. Quality, as at Site 2.

This well was completed under geological advice. The authorities were prepared to abandon it at 200 ft., where it was quite dry.

Dowser *C* located sixteen sites which were proved, mostly by drilling, a few by hand digging. Of these, fourteen were dry holes or yielded too small a supply to be worth pumping, and were abandoned. On test, one well yielded 150 gallons per hour, and another 350–400 gallons per hour. The depths ranged down to 208 ft., but thirteen were of 50 ft. or less. Three may be described in detail; the others showed a similar degree of correlation between forecast and fact.

Dowser *C* at Site 4 (near Philippeville)

	Forecast	*Fact*
Strata	0–20 ft. sand –100 ft. clay. At 105 ft. gravel with water.	0–150 ft. sand. Well abandoned, quite dry.

Dowser *C* at Site 5 (Jemmapes)

Forecast	*Fact*
Water in useful quantities at 92 ft., 190 ft. and 230 ft.	Slight trace of water at 76 ft. Well below 15 ft. drilled practically throughout in clayey strata, and stopped at 208 ft.

At this stage, water at 68 ft. was stated by the dowser to be shut out by the well-casing. This casing was therefore withdrawn to above that depth, but the hole remained dry. The dowser then had 18 lb. of high explosive detonated at 68 ft. to open up the strata and to let in the water, but the only result was a shower of dry clay.

Dowser *C* at Site 6 (Philippeville)

This forecast was made after nineteen auger holes ranging from 3 ft. to 22 ft. deep had been made over the area.

	Forecast	*Fact*
Water	At 14 ft.	At 12 ft. 6 in.
Static level	10 ft.	12 ft. 6 in.
Comment	The intersection of three streams	Since little water was found, boring was continued to 40 ft. without success. It was then converted into a dug well, 15 ft. 6 in. deep, with perforated casing in the bore below this level. The well then yielded 350–400 gallons per hour.

The above forms the sum total of my experience of 'water divining' in Algeria.

It is difficult to appreciate any significant correlation between the information purported to be given by the dowsers in their forecasts and the facts later established—a conclusion perhaps of some practical value.

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Nov. 7.

[1] *Nature*, **151**, 118 (1943).
[2] *Roy. Eng. J.*, **58**, 301 (1944); **59**, 148 (1945).

Nuées ardentes and Ignimbrites

A MODERN text-book of volcanology by Prof. C. A. Cotton, published under the somewhat misleading title "Volcanoes as Landscape Forms"[1], has recently been reviewed in *Nature* by Prof. Arthur Holmes[2]. The book is beautifully illustrated and well documented; it thus fills a gap in British volcanological literature and is likely to be widely read by students of geology. For this reason it seems desirable to add to Prof. Holmes' constructive criticisms by directing attention to certain statements made by Prof. Cotton (pp. 199–215) which seem likely to mislead the reader on two important points: (1) the mode of origin of the *nuée ardente*, from the volcano Montagne Pelée, which overwhelmed the town of St. Pierre in Martinique in 1902; and (2) the state of consolidation of the deposits formed by *nuées ardentes* in the West Indies.

The term *nuée ardente* is used to describe a swiftly moving and very hot avalanche composed of lava blocks and fragments and rapidly expanding dust-laden gases. Such an avalanche with its accompanying dust-laden cloud is the product of a special type of explosive volcanic eruption which was unknown until 1902, when it was studied in the West Indies by Lacroix in Martinique and by Tempest Anderson and Flett in St. Vincent. Controversy arose as to the relative importance of a directed explosive blast, as opposed to the action of gravity alone, in giving to a descending *nuée ardente* its direction and speed. It is now, however, generally agreed that: (*a*) the descent of some *nuées ardentes* is controlled by a directed explosive blast (those discharged laterally from below a 'dome' of almost solid lava occupying a crater, for example, Mt. Pelée and Lassen Peak in California); (*b*) the descent of other *nuées ardentes* is controlled by gravity alone (those produced by an initial vertical explosion in a domeless crater, for example, the Soufrière of St. Vincent, and Kloet in Java); and (*c*) the *nuées ardentes* which overwhelmed St. Pierre in 1902 was of the first-mentioned type ("nuée péléenne d'explosion dirigée" of Lacroix) and was thus the manifestation of an exceptionally dangerous type of volcanic eruption[3].

Prof. Cotton, however, states (p. 200) that the *nuées ardentes* which overwhelmed St. Pierre "frothed over from the crater of Mt. Pelée and was sufficiently voluminous to spread widely . . ."; he gives no reasons for contradicting Lacroix and Perret, the acknowledged authorities on the eruptions of Mt. Pelée.

Nuées ardentes leave in their trail a chaotic deposit of lava fragments (often very large blocks), volcanic ash, and very finely divided volcanic dust. A characteristic feature of such deposits in Martinique[4], in St. Vincent[5] and in Montserrat[6] is their loose, unconsolidated state. Nobody has ever described welded or agglutinated tuffs ('ignimbrites') as products of *nuées ardentes* in the West Indies.

Prof. Cotton, however, in his account of the occurrence and formation of ignimbrites, leaves the reader with the distinct impression that *nuées ardentes* of the type which overwhelmed St. Pierre in 1902 (called by him "voluminous or first-order *nuées ardentes*") usually form extensive and thick sheets of ignimbrite, a firmly agglutinated lava-like rock (pp. 199, 200 and 215). He makes no adequate comment on published descriptions of the deposits left by *nuées ardentes* in the West Indies.

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Oct. 20.

[1] Cotton, C. A., "Volcanoes as Landscape Forms" (Christchurch and London: Whitcombe and Tombs, 1944).
[2] Holmes, A., *Nature*, **156**, 156 (1945).
[3] Lacroix, A., Livre Jubilaire 1830–1930, Soc. géol. de France, **2**, 457–465 (1930). Perret, F. A., "The Eruption of Mt. Pelée 1929–32", *Pub. Carnegie Inst.*, No. 458, 84 (1935). Escher, B. G., *Leid. geol. Meded.*, **6**, Aft. 1, 45–58 (1933). Holmes, A., "Principles of Physical Geology" (Edinburgh: Nelson, 1944), 462, 469.
[4] Lacroix, A., "La Montagne Pelée et ses Éruptions" (Paris: Masson et Cie., 1904), 375–382. Perret, see ref. 3, 48–50.
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[6] MacGregor, A. G., *Phil. Trans.*, B, **229**, 30–34, 67 (1938).

Authenticity of Scientific Anecdotes

Dr. Clement Webb and Prof. Bernard Cohen discuss in *Nature* of February 16, p. 196, the origins of two anecdotes associated with Faraday's demonstration of magneto-electricity mentioned in my book "Discovery", published in 1916. In correspondence with Sir Henry Tizard a short time ago, I suggested that Faraday was aware of Franklin's apt reply, "What is the use of a new-born child?" when asked the use of an invention, and he quoted it in connexion with his own discovery when asked a similar question. In my book, the inquiry was said to have been made at the end of a lecture at the Royal Institution whereas, as Prof. Cohen shows, the occasion was a lecture at the City Philosophical Society and the subject was not magneto-electricity but the discovery of chlorine by Scheele.

Prof. Cohen asks for information upon the second anecdote relating to Faraday's reply to a statesman who asked what was the use of a particular discovery and was told that in all probability he would soon be able to tax it. As stated in my book, the source from which I derived this story was Lecky's "Democracy and Liberty", in the Introduction of which, p. xxxi, the following mention is made of Gladstone's attitude towards scientific studies:

"There were, it is true, wide tracts of knowledge with which he had no sympathy. The whole great field of modern scientific discovery seemed out of his range. An intimate friend of Faraday once described to me how, when Faraday was endeavouring to explain to Gladstone and several others an important new discovery in science, Gladstone's only commentary was 'but, after all, what use is it?' 'Why, sir,' replied Faraday, 'there is every probability that you will soon be able to tax it.'"

Lecky was a distinguished historian, but as he relates only what was told to him I am afraid the evidence as to the truth of the story must remain inconclusive.

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EFFECT OF SOME FATTY ACIDS ON THE OXYGEN UPTAKE OF *MYCOBACT. TUBERCUL. HUM.* IN RELATION TO THEIR BACTERICIDAL ACTION

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IN connexion with our work[1] on antibiotics against *Mycobact. tubercul.* the need of a rapid standardization method led us to try the Warburg technique for measuring the oxygen consumption. This method has been generally used for similar investigations on faster growing bacteria. We have found the method very satisfactory with *Mycobact. tubercul.* if a large amount of bacteria (1·5–6 mgm. wet weight) is used in each vessel. The slow growth of these bacteria seems to have discouraged previous workers on antituberculous substances from using this method. However, it has been shown that the oxygen consumption of *Mycobact. tubercul.* is conveniently measurable with the Warburg technique[2,3].

In our standard procedure we used ordinary Warburg cups with one side-bulb. The main space of the sterilized vessels contained 2·25 ml. 5 per cent glycerol broth (*p*H 7·4) and 1 ml. of the solution containing the substance to be tested. The central cup contained 0·1 ml. 5 per cent potassium hydroxide and the side-bulb 0·3 ml. of a 1 per cent (wet weight) suspension of *Mycobact. tubercul. hum.* in saline. The vessels were shaken (80 strokes per minute) for one hour at 37° to ensure equilibration before admixing the bacteria from the side-bulb. It was generally sufficient to follow the oxygen consumption for eighteen hours.

The bacteria were collected from three-weeks old cultures on Löwenstein egg medium. The strain was isolated in 1944 from a case of human tuberculosis.

The oxygen uptake was in most cases approximately constant during the experiment (0·5–2·5 mm.³ oxygen per hour and mgm. (bacteria) (cf. Fig. 1 (6) and Fig. 2 (12)).

Sometimes it happened that it decreased slightly, but more frequently the oxygen consumption increased quite rapidly up to many times its initial values, resembling the oxygen uptake during the logarithmic growth-phase of faster growing bacteria. This speed-up was entirely due to the tubercle bacteria, for at the end of the experiments the fluid was found not to be contaminated with other bacteria. In fifteen of our 155 standardization series to date, each comprising twenty-two vessels, the oxygen uptake was so slow that no results could be obtained.

When the observation of the oxygen uptake was ended in the Warburg apparatus we transferred the contents into sterilized tubes that were centrifuged. The sediment was inoculated on Löwenstein egg medium and inspected after 2–4 weeks incubation. The results of this incubation thus show the bactericidal effect caused by the compound tested in the Warburg vessel.

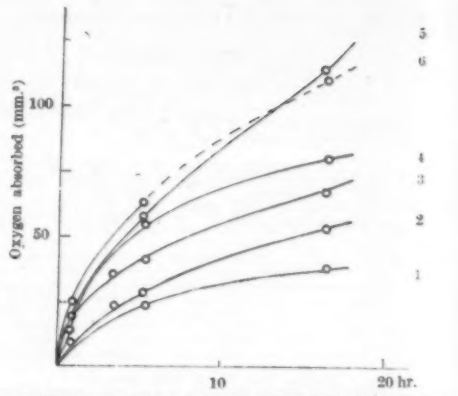

Fig. 1. OXYGEN UPTAKE OF 3 MGM. TUBERCLE BACILLI IN THE PRESENCE OF DI-*n*-HEPTYLACETIC ACID.
(1), 1 : 7,000 (0·5 mgm.); (2), 1 : 14,000 (0·25 mgm.); (3), 1 : 28,000 (0·125 mgm.); (4) 1 : 56,000 (0·063 mgm.); (5), 1 : 112,000 (0·031 mgm.); (6), control.

A typical experiment is shown in Fig. 1, illustrating the effect of diheptylacetic acid. This acid is reported to be bacteriostatic against tubercle at approximately 1 : 50,000[4]. Fig. 1 shows that this acid decreased the oxygen uptake more and more at higher concentrations. The results of the incubation of the bacteria from this experiment are shown in the following table.

Vessel	1	2	3	4	5	6
Bacterial growth	(+)	+	+(+)	++	+(+)	++
Dilution	1 : 7,000	1 : 14,000	1 : 28,000	1 : 56,000	1 : 112,000	1 : ∞

(+), 1–8 colonies; +, fair growth; ++, strong growth.

We have also tested other types of fatty acids and found that the unsaturated ones, namely, oleic, linoleic and linolenic, had a very marked effect on the oxygen uptake of the bacilli. Fig. 2 shows the influence of various concentrations of linolenic acid.

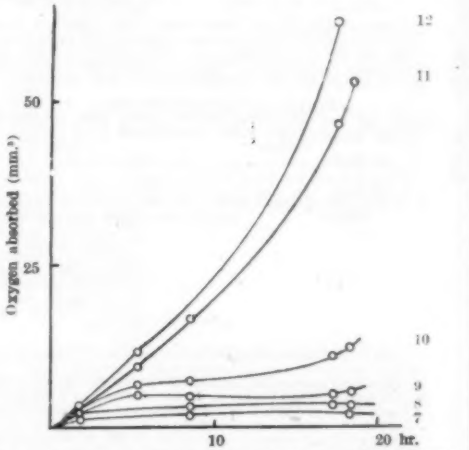

Fig. 2. OXYGEN UPTAKE OF 3 MGM. TUBERCLE BACILLI IN THE PRESENCE OF LINOLENIC ACID.
(7), 1 : 7,000 (0·5 mgm.); (8), 1 : 14,000 (0·25 mgm.); (9), 1 : 28,000 (0·125 mgm.); (10), 1 : 56,000 (0·063 mgm.); (11), 1 : 112,000 (0·031 mgm.); (12), control.

Incubation results from this experiment were as follows:

Vessel	7	8	9	10	11	12
Bacterial growth	0	0	(+)	++	+	++
Dilution	1 : 7,000	1 : 14,000	1 : 28,000	1 : 56,000	1 : 112,000	1 : ∞

0, no growth; (+), 1–8 colonies; +, fair growth; ++, strong growth.

The effect of these unsaturated acids was different from that of the saturated ones (Fig. 1). The unsaturated acids, unlike diheptylacetic acid, regularly showed a certain limit concentration above which the oxygen consumption of the bacteria was practically abolished and below which the bacteria were unaffected. The effect is caused by the double bonds, as stearic acid was completely inactive.

The results of the incubation tests show that linolenic acid had a very strong bactericidal effect, all out of 3 mgm. bacteria being killed at 1 : 14,000 and almost all at 1 : 28,000 after eighteen hours. As will be seen from Fig. 2, the abolition of the oxygen uptake runs parallel with the bactericidal effect. The bacteriostatically most active synthetic acid of Adams *et al.* (loc. cit.) was thus in our experiments considerably less active than the common unsaturated fatty acids occurring in the body.

In five series the following dilutions were found on an average to cause abolition of the oxygen uptake of 3 mgm. bacteria in 3·5 ml. volume:

Oleic acid	1 : 10,000
Linoleic acid	1 : 15,000
Linolenic acid	1 : 30,000

We found that this dilution may vary somewhat with different batches of bacteria, but the relative strengths of the acids are very constant and we were able to obtain reproducible values by always including a 'standard' acid in each series. We also found that bacteria with a greater oxygen uptake are regularly less susceptible to the effect of these acids than bacteria with a small oxygen uptake.

The unsaturated fatty acids obviously get adsorbed to the tubercle bacilli. We observed that the bactericidal activity was considerably decreased in the supernatant liquid after centrifuging off the bacteria after a Warburg experiment.

In correspondence herewith there was a direct proportion between the amount of bacteria added and the quantity of fatty acid needed for the abolition of their oxygen consumption.

Addition of 0·5 ml. of blood plasma reduced the activity 4–8 times. It seems quite likely that the fatty acids are partly adsorbed on the serum proteins, thus decreasing the action on the bacteria.

We have also tested the bacteriostatic activity of the acids mentioned above with the technique of Pryce[5] and Muller[6]. The bacteria, fixed on glass plates, were incubated for seven days in citrated blood, hæmolysed by the addition of an equal volume of water, in which the compound to be tested had been dissolved. Some results are given in the following table:

Dilution	1 : 4,000	1 : 8,000	1 : 16,000	1 : 32,000	1 : 64,000	1 : 128,000	1 : 256,000
Di-*n*-heptylacetic acid	+	+	++	++	++	++	++
Oleic acid	−	(+)	+	++	++	++	++
Linoleic acid	−	−	(+)	(+)	+	++	++
Linolenic acid	−	(+)	(+)	+	++	++	++

− no colonies; (+), few, small colonies; +, few colonies, but size equal to control; ++, equal to control.

As will be seen from the table, the bacteriostatic activity of di-*n*-heptylacetic acid is rather weak in the presence of blood. The common unsaturated fatty acids are more active also in this test. The fact that linolenic acid is less active than linoleic acid might be explained by its more rapid destruction by autoxidation during the incubation.

It seems interesting that these unsaturated acids, occurring normally in the animal body, are more active against tubercle bacilli than the most active saturated acid synthesized hitherto. It is also interesting in view of the numerous reports especially in older literature about treatment of various tuberculous lesions with soaps or oils mainly consisting of these unsaturated fatty acids[7].

During the course of our experiments on the purification of the antibiotica against *Mycobact. tubercul.* mentioned above[8] the Warburg technique proved to be very useful. However, it should be pointed out that the results of Davide[1] cannot be ascribed to the common unsaturated fatty acids.

[1] Davide, *Arkiv Kemi, Min., Geol.*, B, **19**, No. 7 (1945).
[2] Kempner, *Amer. Rev. Tub.*, **46**, 157 (1945).
[3] Dieckmann and Menzel, *Z. Hyg. Inf. Krankh.*, **113**, 709 (1932).
[4] Stanley, Coleman, Greer, Sacks and Roger Adams, *J. Pharmacol.*, **45**, 121 (1932).
[5] Pryce, *J. Path. Bact.*, **53**, 327 (1941).
[6] Muller, *J. Path. Bact.*, **56**, 429 (1944).
[7] Lindenberg and Pestana, *Z. Immun. Forsch.*, **32**, 66 (1921).
[8] To be published later.

DISCOVERY OF ELEMENTS 95 AND 96 AND THE CHEMICAL PROPERTIES OF THE TRANSURANIC ELEMENTS

THE discovery of the elements 95 and 96 was announced on November 16, 1945, by Prof. G. T. Seaborg, of the University of California, now working at the 'Metallurgical Laboratory' of Chicago University (*Ind. and Eng. Chem.*, News Edition, 2085 and 2190; 1945). Isotopes of the two elements—as yet nameless, apparently owing to lack of 'transplutonic' planets—have been produced by bombarding uranium 238 and plutonium 239 with 40 MeV. α-particles in the Berkeley 60-inch cyclotron. Enough material has been made for chemical studies by tracer technique in the way in which the properties of element 93 (neptunium; Np) and 94 (plutonium; Pu) were first investigated in 1940. Nuclear properties of the new elements, including action of neutrons on them, are not discussed in the lecture.

According to Seaborg, the elements beginning from 89 (actinium) have a sufficiently similar electronic structure to warrant their consideration as a group ('actinide series') in the way in which the rare earths are so considered ('lanthanide series'). Although the first members of the actinide group (actinium, thorium, protoactinium, uranium) show great chemical resemblance to the elements in the vertical columns of the Periodic Table, in which they have generally so far been included (yttrium, zirconium, niobium, molybdenum, and lanthanum, hafnium, tantalum, tungsten), later members behave differently: neptunium is quite unlike rhenium, plutonium quite unlike ruthenium or osmium. Seaborg suggests that, beginning with thorium, the *5f* rather

than the 6*d* shell is being filled with electrons. Hence, the characteristic oxidation state for the actinides would be III, as it is for the lanthanides. The higher valency shown by thorium, protoactinium and uranium would be comparable to the anomalous higher valency (IV) of cerium. It has, in fact, been proved that uranium, neptunium and plutonium, though all found in oxidation states III, IV, V, VI, tend more and more towards being in the lower states as the atomic number increases. Element 96 should be stable only in state III, as its electron structure is analogous to that of gadolinium. This prediction is confirmed by experiment.

Some isotopes of elements 93 and 94 are now available in quantity and can be studied by macrochemical methods. Large amounts of Pu 239 (half-life 24,000 years; used for bombs) have been extracted from carbon piles after being formed mainly by slow neutron capture in U 238, with subsequent β-decay of U 239 and Np 239, as reported before. A neptunium isotope is less easily isolated owing to the short half-life (2·3 days) of Np 239. But it is now announced by Seaborg that the α-emitting Np 237, with a half-life of 2·25 million years, is produced in carbon piles in milligram amounts in a side reaction, namely, U 238 (*n*, 2*n*) U 237 with succeeding fairly fast β-decay of the latter to Np 237.

Some aspects of the industrial production of Pu 239 were also touched on. The Hanford extraction plant had to be designed at a time when the world stocks of plutonium were invisible to the naked eye. An expansion by the unprecedented factor of 10^{10} was involved, with the additional complication that all initial steps in a plutonium factory must on health grounds be performed by remote control. Yet the large-scale process has been a complete success from the start. In particular, 'decontamination' from active fission products is achieved to about one part in a million.

It is also mentioned that Seaborg and his group searched for neptunium and plutonium in pitchblende early in 1942, and were able to demonstrate the presence of a small amount of α-activity attributable to plutonium. The concentration was about one part in 10^{11}. The body would clearly not have been detected had not its chemical properties been known in advance. It is presumably produced by the action on U 238 of the ever-present neutrons, some of them derived from spontaneous fission of uranium.

E. Broda.

ADMINISTRATIVE PROBLEMS OF THE UNITED NATIONS ORGANISATION

THE League of Nations has now been replaced by the United Nations Organisation; but whatever the failures of the League in the political field, the value of its achievements in the technical field has always been recognized by informed observers. One of the first tasks of the new organisation has in fact been to consider the most effective way of taking over the work which has been done in such fields as health, the control of the drug traffic and other matters which will now fall within the orbit of the Economic and Social Council. Whatever may be the future of the United Nations Organisation, it will owe much to the earlier League. Not merely is there the League's experience to draw upon but, as a recently issued "Report on the Work of the League, 1943–1944"* shows, even during the years of war, much constructive work was being done in certain limited fields in readiness for the time when international co-operation on a far-reaching scale should again be possible.

This report of the acting Secretary-General, Mr. Sean Lester, shows how important has been the League's contribution in the non-political field and in supplying the factual basis for reconstruction. It is unnecessary here to refer to the five valuable studies on post-war economic problems published by the Economic, Financial and Transit Department during the year, in addition to the re-issue of the "Statistical Year". The same department has also assisted the United Nations Relief and Rehabilitation Administration and the Interim Food and Agriculture Commission. Marked emphasis is laid in the report on the importance of modifications taking place in the field of communications, in regard to structure and organisation, and also methods of operation, and their bearing on the general transport situation in the post-war period. The information which the department is collecting and recording regularly with particular reference to Continental Europe, for example, and the further investigation of the experience gained at the end of the First World War in approaching similar problems should be of considerable value in planning the effort for recovery that must be made. Moreover, in these investigations, which have a direct bearing on the work of the United Nations Relief and Rehabilitation Administration, account is also being taken of long-term reconstruction of means of communication and the establishment of a more fully co-ordinated peace-time transport system.

Just as the work of the Communications and Transit Secretariat has done much to provide a basis for organised collaboration in the future in the field of communications, so the Health Organisation has to a remarkable extent maintained its permanent services, such as biological standardization, epidemiological intelligence and information and documentation. The latter has been concerned not merely with epidemics but also with other health problems such as nutrition, while the Epidemiological Intelligence Service has been able to supply information and technical advice on the epidemic situation and nutritional condition of Europe to various organs of the International Red Cross. Recording the good prospects of the abolition of opium smoking everywhere after the War, the report indicates that legitimate demands for raw opium are rapidly diminishing, and that the raw opium market is likely to face a severe crisis shortly. That conclusion, and the effect of the War in stopping international co-operation concerning narcotic drugs, makes the re-establishment of control a difficult matter and gives high importance to the calling of an early meeting of the Advisory Committee of Traffic in Opium and other Dangerous Drugs.

There are still in existence and functioning the Supervisory Body and the Permanent Control Opium Board, and if the United Nations Organisation succeeds in gaining early control of the threatening situation displayed in this report it will largely be through the agencies inherited from the League.

Nor is it only by the League's own organs that its experience is being sifted and examined with the

* League of Nations. Report on the Work of the League, 1943-1944. Submitted by the Acting Secretary-General. (Official No.: C.14.M.14., 1945.) Pp. 100. (Geneva: League of Nations; London: George Allen and Unwin, Ltd., 1945.) 2*s*.

view of guiding the policy and practices of the United Nations. The Royal Institute of International Affairs has followed up its earlier study of past experience of an international secretariat, with particular reference to recruitment and the conditions for efficient administration, by a study by Chester Purves* of the historical administration of such a secretariat. A further study, by C. W. Jenks†, of the location and status of the headquarters of international institutions is of special interest at the present time as indicating the problems that have still to be faced, even although the decision has been taken to locate the headquarters of the United Nations Organisation in the United States.

Mr. Chester Purves in his notes records experience gained in the day-to-day internal administration of the League of Nations secretariat, particularly that peculiar to the international sphere of which national administration affords little or no experience. Certain questions, such as recruitment and promotion, efficiency and national representation, examined in the previous study, are here developed in greater detail; but nothing is added to what was previously said on the tenure of permanent officials, and as regards the higher directorate attention is confined to staff management proper. Moreover, Mr. Purves brings out very clearly four limiting factors in regard to the activities of the League secretariat: like the League of Nations itself, it was an experimental organisation; the best endeavours to improve the service and enhance its value to the League were defeated by ever-prevailing financial stringency; the budget provisions were too rigid, leaving little or no room to meet emergencies as they arose; and the total number of the staff was too small.

These are all points that the United Nations Organisation must keep clearly in mind, particularly in view of the latest attack on its budget by the U.S.S.R., if it is to profit by past experience and not repeat earlier mistakes. Their importance is repeatedly illustrated by Mr. Purves in discussing particular aspects. He remarks, for example, that the international authority of the future will require a much wider degree of financial latitude than was ever permitted to the League of Nations secretariat in order to be certain of obtaining the best talent available. Here and elsewhere he interposes comments which it is important to note now before the new organisation is built up: the reminder that persons with special linguistic aptitudes do not necessarily make the best administrative officials, or again his careful delineation of the three essential conditions for the sound working of a scheme of seconding young national civil servants to the international secretariat for a period such as six months or a year. On these and other questions Mr. Purves adopts a scientific outlook, like that urged for industry at the recent British Association conference; and it is encouraging to find that so much of his study is reflected in the recommendations and report concerning the secretariat issued by the Executive Committee to the Preparatory Commission of the United Nations‡.

The report indicates that the organisation of the secretariat required by the United Nations is being approached on the lines of scientific management, apart from one important aspect possibly regarded as premature at the present stage. Mr. Purves considers that the most effective and the simplest solution of the problem of providing adequate opportunities for promotion and advancement of the staff would be found in the unification of the administrations of many of the international bodies that may survive the War or be set up after it. This idea he develops in greater detail in the final chapter of his study, and argues that a far greater measure of co-ordination in staff matters is indispensable to the new organisation for world co-operation that is slowly taking shape; and he indicates the advantages in regard to recruitment, allocation of staff, promotions, the co-ordination of dates of conferences, unification of supply services and the like which would result from such a unification. One of his suggestions is for a standing central commission of internal administration, and here it should be noted that the Executive Committee to the Preparatory Commission recommended consideration of the early establishment of an international civil service commission which, though intended to advise primarily on recruitment, might well be extended to embrace such larger functions as Mr. Purves contemplates. Further, the Administrative Committee to be created under Regulation 52 of the Draft Provisional Staff Regulations should meet one of the criticisms of the League secretariat which Mr. Purves advances.

One important chapter links Mr. Purves' study with that of Mr. Jenks' for, considering the problem of location from the administrative point of view, he gives a concise summary of the essential conditions examined in greater detail by Mr. Jenks. Here again it is apparent that the problem has been studied on scientific lines and much more objectively than is supposed; and whatever disappointment may have been felt in Britain that the seat of the United Nations Organisation is to be across the Atlantic, the report by the Executive Committee makes it clear that the Preparatory Commission had before it an objective study representing a most careful appraisal of past experience, much of which has still to be applied in determining the choice of the exact location in the United States. Moreover, the appendixes to Mr. Jenks's study show how extensive is the experience upon which we can draw in considering the concrete problems that have to be solved in establishing an international headquarters, whether of the internationalized area type such as the District of Columbia or of the more modest type of the Vatican City.

What does emerge from Mr. Jenks' study is not a clear-cut conclusion as to which type is theoretically or administratively preferable, but the over-riding importance of ensuring beforehand so far as possible that adequate financial resources, energy, and general, determined and informed support are available to make the choice a success. This study has not appeared too late to contribute, like that of Mr. Purves, to that end; and one need read no more than the verbatim record of the twenty-first meeting of the Executive Committee appended to its report to the Preparatory Commission to realize that there is still much educational work to be done to ensure clear thinking and an objective appraisal of the whole situation. Nevertheless, these several documents indicate that past experience is being examined and

* The Internal Administration of an International Secretariat: Some Notes based on the Experience of the League of Nations. By Chester Purves. (Post-War Problems.) Pp. 78. (London and New York: Royal Institute of International Affairs, 1945.) 4s. 6d. net.

† The Headquarters of International Institutions: a Study of their Location and Status. By C. Wilfred Jenks. (Post-War Problems.) Pp. 102. (London and New York: Royal Institute of International Affairs, 1945.) 6s. net.

‡ Report of the Executive Committee to the Preparatory Commission of the United Nations. (London: H.M. Stationery Office, 1945.) 4s. net.

studied objectively in the spirit of science, and encourage stronger hopes than often appear warranted from the Press accounts that the mistakes of the past are being turned to account, and an honest attempt made to build on that experience institutions as fitting for our present needs of international co-operation as unprejudiced minds can devise.

THE COAST RANGE BATHOLITH, BRITISH COLUMBIA

PROF. T. C. PHEMISTER has made a valuable contribution towards the solution of the ever-present problem of batholithic intrusion (*Quart. J. Geol. Soc.*, 101; 1945). In this, the first detailed paper written on the immense Coast Range batholith, he describes the country and intrusive rocks and their mutual relations in an area of 200 sq. miles which lies astride the contact north of Vancouver, British Columbia.

The country rock, outcropping in Bowen Island, consists of lavas and tuffs of Mesozoic age. These were folded and suffered a low degree of metamorphism before the intrusion of a suite of sub-acid dykes. The emplacement of the granodiorite was a subsequent event, and though this involved the engulfment of vast masses of the country rock with its pre-batholithic dykes, the regional strike of the country rock and the trend of the dykes in these great inclusions were in general preserved unchanged. The mutual relations of the intrusive and inclusions were studied in detail at Caulfield, where a representative inclusion outcrops over an area 1,200 ft. by 600 ft. The contact is a three-dimensional jig-saw referred to three planes, two of which are almost vertical and approximately at right angles and correspond with the regional strike of the country and the trend of the dykes; the third plane is at a low inclination, 20°, to the horizontal.

The resulting interpenetration of granodiorite and country rock is such that the normal conception of stoping cannot be valid here, and Prof. Phemister does not accept the interpretation of these included masses as roof-pendants. He notes the persistence of the dykes, which have very largely remained intact though the country rock has vanished, its former presence being proved by the occasional occurrence of irregular pieces protruding from the dyke-wall into the igneous rock. The author conceives the emplacement of the batholith as a quiet process at not very high temperature, perhaps taking place piecemeal with alternations of liquid and solid in closely adjacent parts of the mass, and with recurring incidents of fusion, solution and crystallization. The country rocks have not been pushed aside, they have not been displaced by a stoping process, and though a process of replacement by mineralizing agents offers a ready explanation of the spatial relations of the contacts, there remains the fact that the rock of the batholith is a granodiorite both on the large scale throughout its immense extent of 1,250 miles by fully 100 miles, whatever the country rock, and on the small scale, when it retains its character right up to the individual contacts.

Our present conception of the magmatic process is certainly inadequate and must be re-examined. Fuller knowledge of the physical and physico-chemical properties of aqueous magmas is necessary for further progress.

GEOLOGY AND PETROLOGY IN THE U.S.S.R. (1943–44)

By S. I. TOMKEIEFF

IT is impossible at the present time to evaluate the progress in the fields of geology and petrology made in the U.S.S.R. during the years of the War, but according to all reports it must be very considerable. The material at hand (*Bull. Acad. Sci. URSS*, Sér. Géol. for 1943 and 1944) amounts only to a small fraction of the total output of published material, and cannot be taken as a representative sample. It will, however, be of interest to geologists of Great Britain to know something of the work done in the U.S.S.R. during these years, and the following represents a brief summary of the most important articles published in the *Bulletin* (the references are given to the year, number and page).

The geological mapping of European Russia on the scale 1 : 420,000 began in 1888 and was completed in 1930. From the modern point of view, however, these maps are highly unsatisfactory, and in 1941 the Moscow Geological Survey appointed a special committee to devise a new scheme of geological mapping. In a preliminary report of this committee (*Bull.*, No. 1, 90; 1944) various schemes of mapping are discussed, including a new scheme of 'complex' mapping, which consists in the preparation of a set of maps for each district comprising stratigraphy (solid and drift), hydrogeology, geomorphology and economic resources.

Papers on stratigraphy, palæontology and tectonics in the *Bulletin* are not numerous. They include papers by I. A. Efremov on the Permian (*Bull.*, No. 6, 52; 1944) and on the dinosaur remains in Central Asia (*Bull.*, No. 3, 40; 1944) and papers by various authors on the reef structures in the Permian (*Bull.*, No. 2, 36, 56; 1943) and on Jurassic stratigraphy (*Bull.*, No. 3, 22, 74, 85; No. 6, 61; 1944).

Tectonics accounts for several papers, notably those by V. G. Bondarchuk on the relation between geotectonics and geomorphology (*Bull.*, No. 1, 107; 1944), by S. S. Shultz on the orogenesis of the Tian-Shan (*Bull.*, No. 2, 11; 1944), by V. A. Aprodov on the relation between tectonics and petroleum deposits (*Bull.*, No. 2, 70; 1943) and by J. S. Edelstein on a new scheme of tectonic subdivision of Siberia (*Bull.*, No. 6, 14; 1944).

The work published on coal and coal deposits involves stratigraphy, tectonics and petrology, as for example that by E. A. Perepechina (*Bull.*, Nos. 4–5, 82; 1943) and A. T. Donabedov (*Bull.*, Nos. 4–5, 98; 1943) in which the preliminary results of the application of a new method are presented. This method (I believe that it has been tried in Britain) consists in correlating the rank of coal with certain physical properties, such as density, porosity and mechanical properties of the enclosing scales and sandstones. The Urals certainly offer an exceptionally favourable district for the study of rank variation in coal, as there the coals range from the Devonian to the Tertiary, and they also vary in rank within the same formation. The influence of tectonic factors on the rank of coals is discussed by I. I. Gorsky (*Bull.*, No. 6, 28; 1943), while P. I. Dorofeev presents an interesting picture of the migration of coal-bearing facies in the Uralian area of deposition during the Devonian-Permian and the Mesozoic eras. In the first instance the coal-bearing facies migrated from the south to the north; in the second they fanned out from an easterly direction (*Bull.*, No. 1, 75; 1944).

The majority of papers dealing with the geology of petroleum are apparently published elsewhere, but the article by A. I. Nikonov (*Bull.*, No. 18 ; 1943), on the measurement of the radioactivity of rocks in boreholes by means of a gamma-ray counter, may be of interest to geologists. The results indicate that the fine-grained argillaceous sediments show maximum and the limestones minimum radioactivity.

Following the lead of America, petrology in the U.S.S.R. is becoming more and more the handmaid of economic geology, without, however, losing its position as an independent science. Rather the reverse—pure petrology is getting enormously enriched through the experience gained in the applied field. The War has considerably intensified the search for mineral deposits, and as a result the majority of papers published in the volumes under review deal directly or indirectly with mineral deposits. A large number of papers is devoted to the deposits of copper and iron pyrites of the Urals, and it is interesting to note that they are all centred around a hypothesis concerning the genesis of these ores. This hypothesis was first introduced by A. N. Zavaritzky in 1926 and, so far as one can see, it is not definitely accepted by all the petrologists. In opposition to the previously held hypothesis, according to which the pyritic deposits were formed during a later period of Uralian orogenesis and were deposited along tectonic crush zones, Zavaritzky affirmed that these ores were derived from magmatic fluids associated with Devonian eruptive activity and that the ore-impregnated breccias are not of tectonic but of volcanic origin. In support of his hypothesis, Zavaritzky describes several new localities in the southern Urals where the ore is found among only slightly metamorphosed lavas and tuffs (*Bull.*, No. 1, 3, 25 ; No. 3, 3 ; 1943). In this he is supported by his namesake, V. A. Zavaritzky (*Bull.*, No. 1, 47, 59 ; 1943), A. V. Peck (*Bull.*, No. 1, 14 ; 1943), S. N. Ivanov (*Bull.*, No. 1, 20 ; 1943 ; *Bull.*, No. 5, 125 ; 1944) and V. M. Sergievsky (*Bull.*, No. 5, 113 ; 1944) and opposed by N. A. Shtreiss (*Bull.*, No. 1, 74 ; 1943) and A. A. Petrenko (*Bull.*, No. 1, 87 ; 1943).

Nickel ores of sedimentary origin of the southern Urals are described by D. V. Nalivkin (*Bull.*, No. 6, 3 ; 1943), A. L. Kaz (*Bull.*, No. 6, 112 ; 1943) and I. I. Gisburg (*Bull.*, No. 6, 7 ; 1943). A general scheme of the genetic classification of manganese ores is presented very ably by A. G. Betekhtin (*Bull.*, No. 4, 3 ; 1944 ; see *Nature*, **156**, 87 ; 1945), while others describe the manganese deposits of Kazakhstan (*Bull.*, No. 4, 86 ; 1944), northern Urals (*Bull.*, No. 4, 59 ; 1944) and Siberia. Among other ores described one may mention urano-vanadium ores described by B. A. Turin (*Bull.*, No. 2, 99 ; 1944), siderite ores by A. Chumakov and N. S. Mysnikov (*Bull.*, No. 2, 87 ; 1944) and bauxite ores by N. S. Iljina (*Bull.*, No. 1, 83 ; 1944).

Papers on pure petrology are few but of a high standard. Among them the papers by A. N. Zavaritzky (*Bull.*, No. 5, 212 ; 1944) and V. A. Nikolaev (*Bull.*, No. 5, 51 ; 1944) are of particular interest to petrologists, as they deal with one of the most important problems in petrogenesis, namely, the process of separation of volatile components of the magma and the physico-chemical laws regulating the formation of pegmatites. Descriptive papers are confined to the account of certain ultrabasic rocks of the Kola peninsula by A. A. Polkanov (*Bull.*, No. 6, 34 ; 1944) and the mode of occurrence and genesis of the mineral pumpellyite among the volcanic and metamorphic rocks of the Urals by D. S. Korjinsky (No. 5, 87 ; 1944) and V. A. Zavaritzky (No. 5, 92 ; 1944). Finally, one may mention a new attempt at a quantitative classification of the lamprophyres by B. M. Kupletsky (No. 5, 98 ; 1944), and a discussion of the problem of the heterogeneity of the foyaites by A. A. Polkanov (No. 5, 41 ; 1944).

APPLICATION OF D.D.T. AS AN INSECTICIDE

THREE papers dealing with the practical application of D.D.T. (dichloro-diphenyl-trichloroethane) as an insecticide are published in the *Bulletin of Entomological Research* (**36**, Part 3 ; Nov. 1945). Messrs. D. W. Wright and D. G. Ashby discuss the results of experiments involving its use in controlling the carrot fly (*Psila rosæ*). It appears that D.D.T. is likely to prove extremely valuable in this connexion when used as a spray of 0·5–1 per cent concentration. Its toxicity to the adult flies and permanence on foliage under all weather conditions give it undoubted advantages. Thus a 1 per cent emulsion applied to carrot foliage in the field gave 100 per cent mortality of carrot flies in the laboratory for 26 days after treatment. From a treated surface the insect acquires a lethal dose in a very short time, apparently by absorption through the pads of the feet.

Miss Sarah Banks discusses the residual toxicity of D.D.T. to the bed-bug (*Cimex lectularius*). Her investigations led to the conclusion that D.D.T. is more toxic when available on a given surface as an oil solution than as a dry film. Three months after being sprayed with D.D.T. (0·23 mgm. per sq. cm.), cement and plain wood kill approximately 80 per cent of the bed-bugs exposed thereon : after six months these surfaces still yield about 60 per cent mortality. Glass treated with a deposit of only 0·03 mgm. per sq. cm. yielded similar kills at the corresponding periods. When used as a spray and compared with other insecticides tested along with it, D.D.T. was ten times less toxic to bed-bugs than pyrethrum ; but on the other hand its residual effect was far more effective than pyrethrum.

The third paper is by Major C. R. Ribbands, on the use of D.D.T. as a mosquito larvicide. When 5 per cent D.D.T. in oil is applied at the rate of only 1 pint per acre of still water (= 1 oz. D.D.T. per acre), it was found to be lethal to both Anopheline and Culicine larvæ within 24 hours under optimum conditions. The most important property of D.D.T. in oil is that it appears to be lethal in a monomolecular film. This enables it to spread rapidly over a very large surface from the point of application and allows such applications to be applied at stated intervals only, instead of a spray to cover the whole surface of a breeding area. While no special apparatus is necessary for the satisfactory application of D.D.T. in oil, it is convenient to use a simple device which will throw a measured dose to a distance. Larvæ, for example, were successfully eliminated from a large marsh simply by throwing 5 per cent D.D.T. in oil from 3 in. × 1 in. tubes of about 5 c.c. capacity and applied at intervals of 12 ft. around the perimeter. It is emphasized, however, that R.K.W. oil squirts provide a suitable simple apparatus for this purpose. [See also p. 285 of this issue.]

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, March 11

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 5.30 p.m.—Mr. G. Seligman: "Explorations of the Jungfraujoch Research Party" (Geographical films with Commentary).

SOCIETY OF CHEMICAL INDUSTRY, YORKSHIRE SECTION (in the Chemistry Lecture Theatre, The University, Leeds), at 5.45 p.m.—Annual General Meeting; at 6.15 p.m.—Dr. L. J. Burrage: "Benzene Hexachloride, its Chemical and Insecticidal Properties".

Tuesday, March 12

ZOOLOGICAL SOCIETY OF LONDON (joint meeting with the INSTITUTE FOR THE STUDY OF ANIMAL BEHAVIOUR and the BRITISH ORNITHOLOGISTS' UNION, at Regent's Park, London, N.W.8), at 5 p.m.—Dr. Edward Hindle, F.R.S.: "The Swallow" (cinematograph film); Prof. N. Tinbergen: "The Experimental Analysis of Instinctive Behaviour".

INSTITUTION OF CHEMICAL ENGINEERS (joint meeting with the CHEMICAL ENGINEERING GROUP, at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. A. R. Morcom: "Fluid Flow through Granular Materials".

UNITED NATIONS FELLOWSHIP (at the Royal Empire Society, Northumberland Avenue, London, W.C.2), at 6.15 p.m.—Prof. R. H. Soltau: "The Middle East (excluding Palestine)".*

Wednesday, March 13

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. Clough Williams-Ellis: "National Parks".

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 3 p.m.—Annual General Meeting. Prof. A. E. Trueman, F.R.S.: "Stratigraphical Problems in the Coal Measures of Europe and North America" (Presidential Address).

PHYSICAL SOCIETY, COLOUR GROUP (in the Lecture Theatre of the Science Museum, Exhibition Road, London, S.W.7), at 3.15 p.m.—Annual General Meeting; at 3.30 p.m.—Mr. E. J. Bowen, F.R.S.: "Light Absorption and Elementary Wave Mechanics".

INSTITUTE OF PETROLEUM (at the Royal Society of Tropical Medicine, 26 Portland Place, London, W.1), at 4.30 p.m.—Annual General Meeting; at 5.30 p.m.—Dr. J. F. Walter: "The Development of Fluid Catalytic Cracking".

INSTITUTION OF ELECTRICAL ENGINEERS, TRANSMISSION SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. A. Langley Morris: "Three-Phase Distribution and Electric Welding and Furnace Loads".

INSTITUTE OF FUEL (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—Mr. Oliver Lyle: "Inefficiency".

INSTITUTE OF WELDING, WEST SCOTLAND BRANCH (at 39 Elmbank Crescent, Glasgow, C.2), at 6.30 p.m.—Mr. H. Martin: "Welding of Non-ferrous Metals".

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Scientific Papers.

THE POLYTECHNIC (in the Fyvie Hall, The Polytechnic, Regent Street, London, W.1), at 6.30 p.m.—Mr. Michael Balcon: "The Film To-day", 4: "A Film is Born".*

INSTITUTE OF WELDING, MANCHESTER BRANCH (at the Reynolds Hall, College of Technology, Manchester), at 7 p.m.—Annual General Meeting. Symposium on "The Welding of Thin Materials".

INSTITUTE OF WELDING, NORTH LONDON BRANCH (at the East Ham Technical College, East Ham, London, E.6), at 7.30 p.m.—Dr. E. G. West: "Metallurgical Aspects of the Welding of Light Alloys".

BIRKBECK COLLEGE STUDENTS' UNION (in the Physics Lecture Theatre, Birkbeck College, Breams Buildings, Fetter Lane, London, E.C.4), at 8 p.m.—Mr. A. L. Bacharach: "Penicillin".

Thursday, March 14

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir Henry Dale, O.M., G.B.E., F.R.S.: "Chemical Transmitters of the Effects of Nervous Impulses", 3: "Transmission of Excitation in Nerve Ganglia".

INSTITUTION OF ELECTRICAL ENGINEERS, INSTALLATIONS SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. R. Grierson and Mr. Forbes Jackson: "Engineering Principles Applied to the Design and Construction of Domestic Water-Heating Machines of the Solid-Fuel/Electric Type".

WOMEN'S ENGINEERING SOCIETY, MANCHESTER BRANCH (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. J. Batten: "Broadcasting in Wartime".

Wednesday, March 13—Thursday, March 14

INSTITUTE OF METALS (at the Institution of Civil Engineers, Great George Street, London, S.W.1).—Annual General Meeting.

Friday, March 15

PHYSICAL SOCIETY (in the Physics Department, Imperial College, Imperial Institute Road, London, S.W.7), at 5 p.m.—Scientific Papers.

Saturday, March 16

BIOCHEMICAL SOCIETY (at King's College, Strand, London, W.C.2), at 2.15 p.m.—Annual General Meeting.

INSTITUTE OF PHYSICS, MANCHESTER AND DISTRICT BRANCH (in the large Physics Theatre, The University, Oxford Road, Manchester), at 2.30 p.m.—Dr. F. A. Freeth, F.R.S.: "The Education and Training of Physicists".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

DEMONSTRATOR IN PHYSIOLOGY AND PHARMACOLOGY—The Dean of the Medical College, St. Bartholomew's Hospital, West Smithfield, London, E.C.1 (March 15).

LECTURER IN THE DEPARTMENT OF ELECTRICAL ENGINEERING—The Registrar, The University, Sheffield (March 15).

LECTURER IN ELECTRICAL ENGINEERING—The Principal, West Ham Municipal College, Romford Road, Stratford, London, E.15 (March 16).

LECTURER IN MECHANICAL ENGINEERING—The Clerk to the Governors, South-East Essex Technical College, Longbridge Road, Dagenham, Essex (March 18).

LECTURER IN CHEMISTRY—The Principal, Acton Technical College, High Street, Acton, London, W.3 (March 18).

ASSISTANT LECTURER IN TEXTILE ENGINEERING, and an ASSISTANT LECTURER IN WEAVING—The Registrar, College of Technology, Manchester 1 (March 18).

RESIDENT TUTORS IN MATHEMATICS, CHEMISTRY, PHYSICS, BIOLOGY (specializing in PLANT BIOLOGY), and GEOGRAPHY, at the Makerere College, Uganda—The Secretary, Makerere College Committee, 28 Grosvenor Street, London, W.1 (March 22).

LECTURER (woman) in BIOLOGY—The Principal, Bishop Otter College, Chichester (March 23).

LECTURERS IN THE DEPARTMENT OF INDUSTRIAL METALLURGY (one appointment may be made for Foundry Metallurgy and one for the Metallurgy of Wrought Fabrication)—The Secretary, The University, Edmund Street, Birmingham 3 (March 25).

OFFICER-IN-CHARGE, METEOROLOGICAL PHYSICS RESEARCH, Council for Scientific and Industrial Research, Melbourne—The Secretary, Australian Scientific Research Liaison Office, Australia House, Strand, London, W.C.2 (March 29).

CHAIR OF ZOOLOGY—The Registrar, University College, Southampton (March 31).

ASSISTANT LECTURER IN GEOGRAPHY—The Registrar, The University, Sheffield (April 3).

ASSISTANT LECTURER IN PHILOSOPHY—The Registrar, The University, Sheffield (April 30).

LECTURER IN TROPICAL HYGIENE—The Dean, School of Tropical Medicine, Pembroke Place, Liverpool 3, endorsed "Lectureship in Tropical Hygiene" (April 30).

SENIOR LECTURER IN PHYSICS—The Registrar, The University, Sydney, N.S.W., Australia (April 30).

BACTERIOLOGIST to work on the intestinal flora, and a BIOCHEMIST, preferably but not necessarily with bacteriological knowledge, for microbiological assay of the vitamins—The Secretary, National Institute for Research in Dairying, Shinfield, Reading.

LECTURER, and an ASSISTANT LECTURER, in PHYSICS—The Secretary, King's College, Strand, London, W.C.2.

LECTURER (woman) IN BIOLOGY at the City of Birmingham Training College—The Chief Education Officer, Secondary Education Department, Education Office, Margaret Street, Birmingham 3, endorsed "S.E. Department".

SENIOR LABORATORY TECHNICIAN with experience in Biochemical, Bacteriological and Histological methods—The Secretary-Superintendent, General Infirmary, Burton-on-Trent.

SENIOR SCIENTIFIC OFFICER in charge of Seed Propagations, a SCIENTIFIC OFFICER in charge of Horticultural Crops, SCIENTIFIC OFFICERS for Seed Production Committee, and a SCIENTIFIC OFFICER for the Official Seed Testing Station—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

SENIOR RESEARCH WORKER—The Director, Department of Applied Economics, c/o Marshall Library, Downing Street, Cambridge.

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